

AD-A096 521      ARMY ENGINEER WATERWAYS EXPERIMENT STATION VICKSBURG--ETC F/G 13/2  
HS320 - LOCK FILLING AND EMPTYING SYMMETRICAL SYSTEMS, PROGRAM --ETC(U)  
JUN 78 F M NEILSON, M T HEBLER

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DISTRIBUTION STATEMENT

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ELECTRONIC COMPUTER PROGRAM ABSTRACT			
TITLE OF PROGRAM		PROGRAM NO. NAME	
H5320 - Lock Filling and Emptying Symmetrical Systems		722-F3-RO-5J1	
PREPARING AGENCY Hydraulic Analysis Division, Hydraulics Laboratory, U. S. Army Engineer Waterways Experiment Station, P. O. Box 631, Vicksburg, MS. 39180			
AUTHOR(S)	DATE PROGRAM COMPLETED		STATUS OF PROGRAM
Frank M. Neilson Martin T. Hebler	March 1976 Documented June 1978		PHASE Origin STAGE Operational
A. PURPOSE OF PROGRAM			
To determine the hydraulic performance of a lock culvert system.			
<p style="text-align: center;"><b>LEVEL</b> <span style="float: right;">(12)</span></p> <p style="text-align: center;">RTIC</p> <p style="text-align: right;">S MAR 11 1981 C</p>			
B. PROGRAM SPECIFICATIONS			
SEE FOLLOWING PAGES.			
C. METHODS			
<p>The program is written in G635 time-share series, FORTRAN IV, and is part of a Conversationally Oriented Real-Time Program-Generating System (CORPS). The program consists of a main program, three function subprograms, and six subroutines. The specific function and relation of all these routines can be found in the FUNCTIONAL FLOW CHART, PART II: COMPUTER FUNCTIONAL DESCRIPTION of this abstract.</p>			
D. EQUIPMENT DETAILS			
<p>The program was developed and is operational on the WES G635, Vicksburg, MS. It is also operational on HIS66/80, Macon, GA, and Boeing CDC, Seattle, WA.</p>			
E. INPUT-OUTPUT			
<p>All inputs for program H5320 are either read from a permanent data file or are cued and read upon entry to the input subroutine DATA F. All specific input/output requirements for program H5320 are given in PART II: COMPUTER FUNCTIONAL DESCRIPTION of this abstract.</p>			
F. ADDITIONAL REMARKS			
<p>Complete documentation of this program is available from the Engineer Computer Programs Library, Technical Information Center, WES.</p>			
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B. PROGRAM SPECIFICATIONS:

Language: ANSI FORTRAN (FORTRAN IV)

Solution Requirements: The run command

RUN WESLIB/CORPS/H5320,R

plus the necessary input data.

Method of Analysis: A finite difference scheme is used to determine the flow rate through the culverts and water surface elevation in the chamber during a lock operation.

Core Requirements G635: 21 K words.

External Storage: Type of storage - disk. A user may have an input permanent data file with a maximum of 1 K G635 ASCII words. If the user does not have an input data file, one of the same size and user named will be created during a run of this program. If a user decides to save output for graphics and/or other use, a user named output file with a maximum of 13 K G635 ASCII words will be created. If the output file exists, then the existing output file is used.

General Equation: The governing equation is:

$$(k_1 + k_2 + k_v(t) + k_3 + k_4) \frac{V(t)^2}{2g} = \epsilon [Z_{ref} - z(t)] - \frac{L}{g} \left( \frac{dv}{dt} \right)$$

Where  $k_1$ ,  $k_2$ ,  $k_3$ , and  $k_4$  = constant loss coefficient values for the intake, upstream conduit, downstream conduit, and exit manifold.

200-20

Accession #	100-100
NTIS #	100-100
DTIC #	100-100
Unnumbered	100-100
Justification	200-20
By	100-100
Disposition	100-100
Available	100-100
Discard	100-100

A

$k_v(t)$  = the valve loss coefficient which is a variable during valve opening and has a preset value of 0.1 for a full open valve

$v(t)$  = velocity of flow at a reference location in the culvert(s) at time  $t$ , fps

$g$  = acceleration of gravity, 32.2 ft/sec<sup>2</sup>

$\epsilon$  = operation type ( $\epsilon = 1$  for filling;  $\epsilon = -1$  for emptying)

$z_{ref}$  = upper pool elevation  $z_u$  (filling) and lower pool elevation  $z_L$  (emptying), ft-datum

$z(t)$  = water-surface elevation in lock chamber at time  $t$ , ft-datum

$L$  = culvert length, ft

$\frac{dv}{dt}$  = rate of change of velocity of water in the culvert at time  $t$ , ft/sec<sup>2</sup>

Range of Quantities: Unlimited for practical applications.

Accuracy: Governed by accuracy of input data; the accumulative velocity error is a measure of the accuracy of the solution.

REF: ER 1110-1-10 - ENGINEERING AND DESIGN - Engineering Computer Program Library Standards and Documentation, Appendix B

PART I: ENGINEERING DESCRIPTION

1. PROGRAM NUMBER: 722-F3-RO-5J1
2. TITLE: H5320 - Lock Filling and Emptying Symmetrical Systems
3. REVISION LOG: N/A
4. PURPOSE OF PROGRAM: The purpose of the program is to determine the hydraulic performance of a lock culvert system. The core of the program is a finite difference scheme which is used to determine flow rate through the culverts and water-surface elevation in the chamber during a lock operation. Once these are known, other important hydraulic parameters are evaluated. The program output contains the following computed quantities.
  - a. Single Values.
    - (1) Operation time ( $T$ ), min.
    - (2) Overtravel ( $d_o$ ), ft, and time ( $T_m$ ), min., of occurrence.
  - b. Time Dependent Values.
    - (3) Time ( $t$ ), min.
    - (4) Valve opening ratio ( $b|B$ ).
    - (5) Total inflow ( $Q$ ), cfs.
    - (6) Velocity head ( $h_v$ ), ft, at the reference area.
    - (7) Velocity head ( $h_{vv}$ ), ft, just downstream from the valve.
    - (8) Water-surface elevation ( $z$ ), ft-datum, in the lock chamber.
    - (9) Water-surface elevation ( $z_{uw}$ ), ft-datum, in the upstream valve well.

- (10) Water-surface elevation ( $z_{dw}$ ), ft-datum, in the downstream valve well.
- (11) Piezometric head ( $h_p$ ), ft-datum, at the culvert roof just downstream from the valve.
- (12) Cavitation index ( $\sigma$ ).
- (13) Average velocity ( $V$ ), fps, in the culvert at the reference area.
- (14) Rate-of-rise ( $d_z/d_t$ ), ft/min., of the lock chamber water surface.
- (15) Head losses ( $H_{\ell 1}$ ,  $H_{\ell 2}$ ,  $H_{\ell v}$ ,  $H_{\ell 3}$ ,  $H_{\ell 4}$ , and  $H_{\ell T}$ ), ft, for culvert intake, upstream conduit, valve, downstream conduit, culvert exit, and overall culvert system(s), respectively.
- (16) Effective inertia ( $H_e$ ), ft, in the flow in the culvert.
- (17) Overall drop ( $H_t = H_{\ell 1} + H_{\ell 2} + H_{\ell v} + H_{\ell 3} + H_{\ell 4} + H_e$ ), ft, in water-surface elevation.

5. STEP SOLUTION:

a. Mathematical Formulation. The distribution of total head at an instant during a lock filling operation is assumed to be as shown in Figure 1; a comparable distribution is assumed for an emptying operation. The manner in which each item shown in Figure 1 is used in setting up the mathematical model is described in Table 1. Two simultaneous first-order differential equations are solved as a function of time ( $t$ ); these equations are either equations (1a) and (2), or (1b) and (2), in the following listing.

(1) Conservation of Energy.

(a) Normal Flow 
$$\frac{KV^2}{2g} = \epsilon(z_{ref} - z) - H_e \quad (1a)$$

or

$$(b) \text{ Reverse Flow} \quad \frac{-KV^2}{2g} = \epsilon(z_{\text{ref}} - z) - H_e \quad (1b)$$

(2) Continuity (Normal and Reverse Flows)

$$\frac{dz}{dt} = \epsilon A_r V \quad (2)$$

The variables in equations (1a), (1b), and (2) are as listed in Table 1 with the following exceptions:

$K = k_1 + k_2 + k_v + k_3 + k_4$ ; where  $k_v$  and  $K$  are known functions of time.

$\epsilon = 1$  for filling  
 $-1$  for emptying

$A_r = A_L/n_c A_c$ ; where  $A_L$  is the surface area in the lock chamber and

$dz/dt$  = the rate-of-change of the elevation of the chamber water surface;  $dz/dt$  is positive for a rising water level.

The only boundary conditions prescribed are those when  $t = 0$ ,

$z = Z_L$  for filling  
 $Z_u$  for emptying

$V = 0$

$K = \infty$

b. Time Steps. A known time ( $t_i$ ) is advanced by a constant value ( $\Delta t$ ) to a new time ( $t_{i+1} = t_i + \Delta t$ ). Values of  $i$  that are of specific interest are listed below.

<u>Value of <math>i</math></u>	<u>Condition</u>
1	Initial value (i.e., $t_i = 0.0$ )

<u>Value of i</u>	<u>Condition</u>
N	Valve is fully open (i.e., $k_{i+1} = k_i$ for $i \geq N$ )
M1	Lock operation is complete
	Filling: $z_{M1-1} < z_u \leq z_{M1}$
	Emptying: $z_{M1-1} > z_L \geq z_{M1}$
M2	Maximum overfill or overempty
	Filling: $z_{M2-1} < z_{M2} > z_{M2+1}$
	Emptying: $z_{M2-1} > z_{M2} < z_{M2+1}$
M	Final value (i.e., $t_M = (M - 1) \Delta t$ )
<u>Known:</u>	$v_i, z_i, k_{i+1}, k_{i+2}$

1st Prediction  $v_{i+1} = F_p(z_i, v_i, k_{i+1})$

$z_{i+1}$  from equation (4)

2nd Prediction:  $v_{i+2} = F_p(z_{i+1}, v_{i+1}, k_{i+2})$   
 $z_{i+2} = z_{i+1} + \epsilon \left( \frac{v_{i+2} + v_{i+1}}{2} \right) A_r \Delta t$  Iteration loop A

Corrector:  $v_{i+1} = F_p(z_i, v_i \text{ and } v_{i+2}, k_{i+1})$

$z_{i+1}$  from equation (4)

Letting superscript  $j = 1, 2, 3, \dots$  represents the number trials (loop A above), the sequence is terminated when

$$(z_{i+1})^j - (z_{i+1})^{j-1} \leq 1(10^{-4})$$

In this program  $M$  is the overall control. For example, if  $M$  is preset to a value less than  $N$  the solution will terminate before the valve is full open (i.e.,  $M < N$ ); filling time and overtravel will not be evaluated.

c. Numerical Integration (Predictor-Corrector). Equations (2a) and (2b) are considered in the form

$$v_{i+1}^2 = \pm \frac{2g}{K_{i+1}} \left[ \epsilon(z_{\text{ref}} - z_{i+1}) - \frac{L}{g} \frac{dv}{dt}_{i+1} \right] \quad (3)$$

Equation (2), using a first-order difference, is approximated by

$$z_{i+1} = z_i + \epsilon \frac{v_{i+1} + v_i}{2} A_r \Delta t \quad (4)$$

The predictor is based on the backwards difference

$$\frac{dv}{dt}_{i+1} \approx \frac{v_{i+1} - v_i}{\Delta t} \quad (5)$$

Whereas the corrector uses the centered difference

$$\frac{dv}{dt}_{i+1} \approx \frac{v_{i+2} - v_i}{2\Delta t} \quad (6)$$

Substituting (4) and (5) in (3), and (4) and (6) in (3), yields the predictor,  $F_p(z, v, K)$  and the corrector functions  $F_c(z, v, K)$ , respectively. The algebraic relationships are shown in Table 1; the sequence of calculations at each time step is as follows.

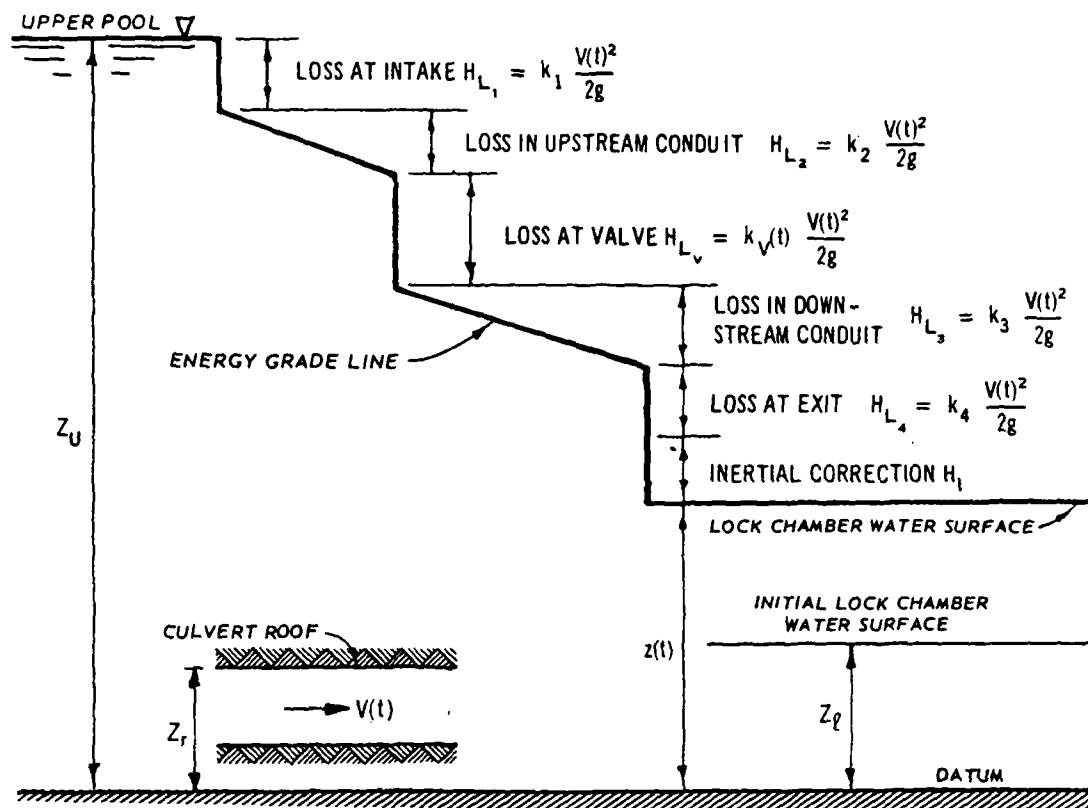


Figure 1. Simulated flow conditions at time  $t$  (filling operation)

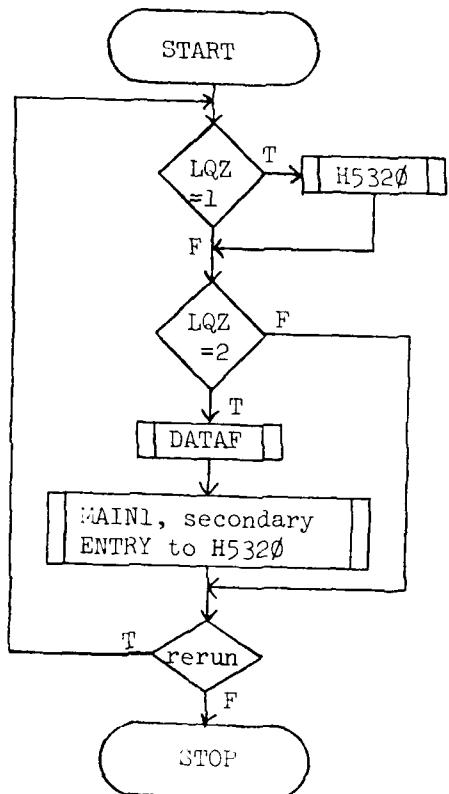
Table 1. Parameters Used in Setting Up the Basic Model

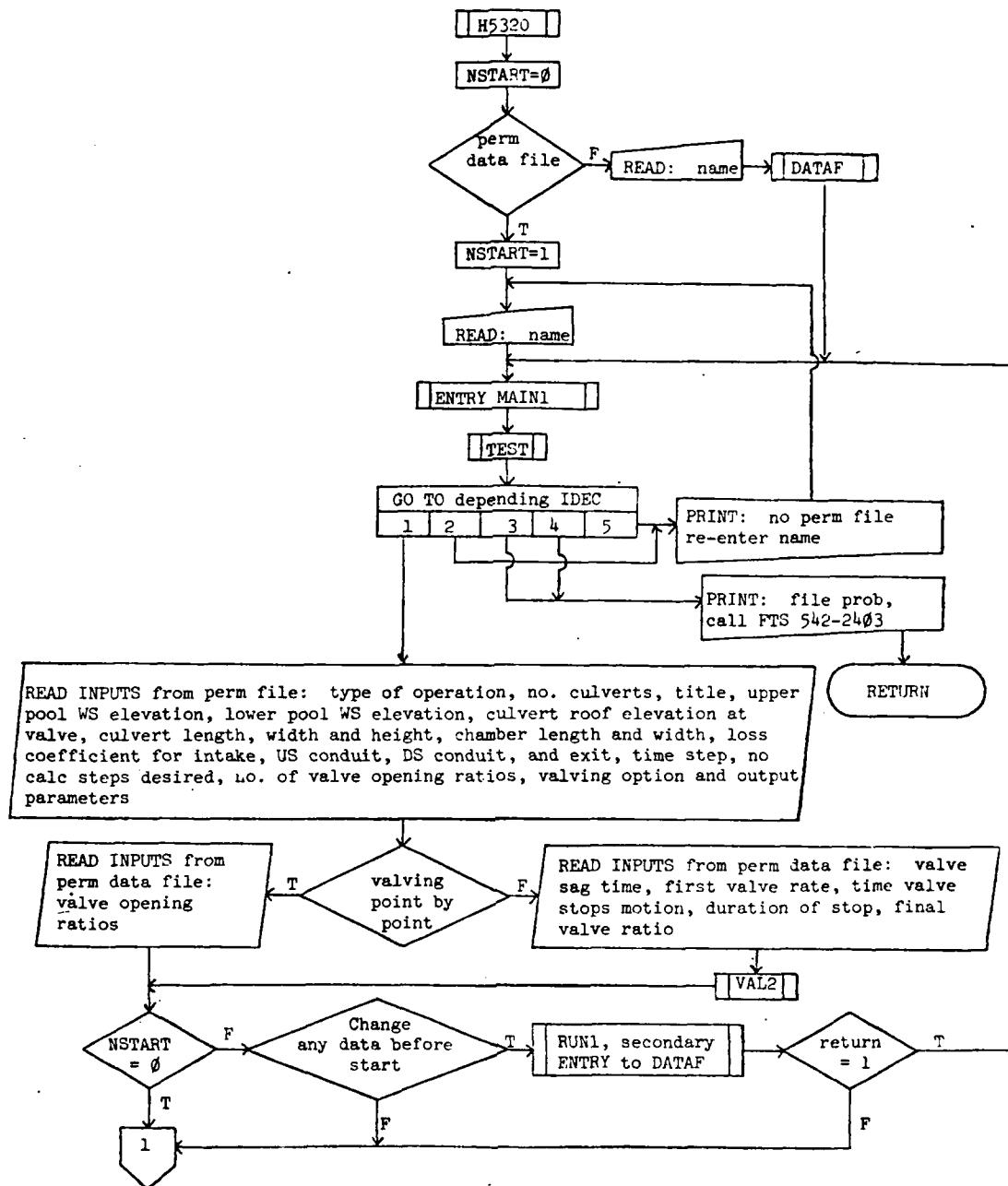
Item (Refer to Figure 1)	Type of Operation	Description
1. Fixed pool elevation, $Z_{ref}$	Filling	$Z_u$ upper pool elevation
	Emptying	$Z_L$ , lower pool elevation
2. Variable water-surface elevation (z)	Both	lock chamber water-surface elevation
3. Reference area, A	Both	$A = n_c A_c$ , where $A_c$ is the cross-sectional area of the culvert immediately below the valve, and $n_c$ equals 1 or 2 for single or double valve operation, respectively.
4. Flowrate, Q	Filling Emptying	Total inflow (outflow is negative) Total outflow (inflow is negative)
5. Reference velocity, V	Both	$V = Q/A$
6. Intake loss, $H_{\ell 1} = \frac{K_1 V  V }{2g}$	Filling	Headloss at the culvert intake; $K_1$ is constant
	Emptying	Headloss between the chamber and the culverts; $K_1$ is constant
7. First conduit loss, $H_{\ell 2} = \frac{K_2 V  V }{2g}$	Both	Loss in the culvert upstream from the valve; $K_2$ is constant
8. Valve loss, $H_{\ell v} = \frac{K_v V  V }{2g}$	Both	Loss at the valve ( $K_v$ is a function of the valve opening ratio until full open; $K_v = 0.10$ thereafter)
9. Second conduit loss, $H_{\ell 3} = \frac{K_3 V  V }{2g}$	Both	Loss in the culvert downstream from the valve; $K_3$ is constant

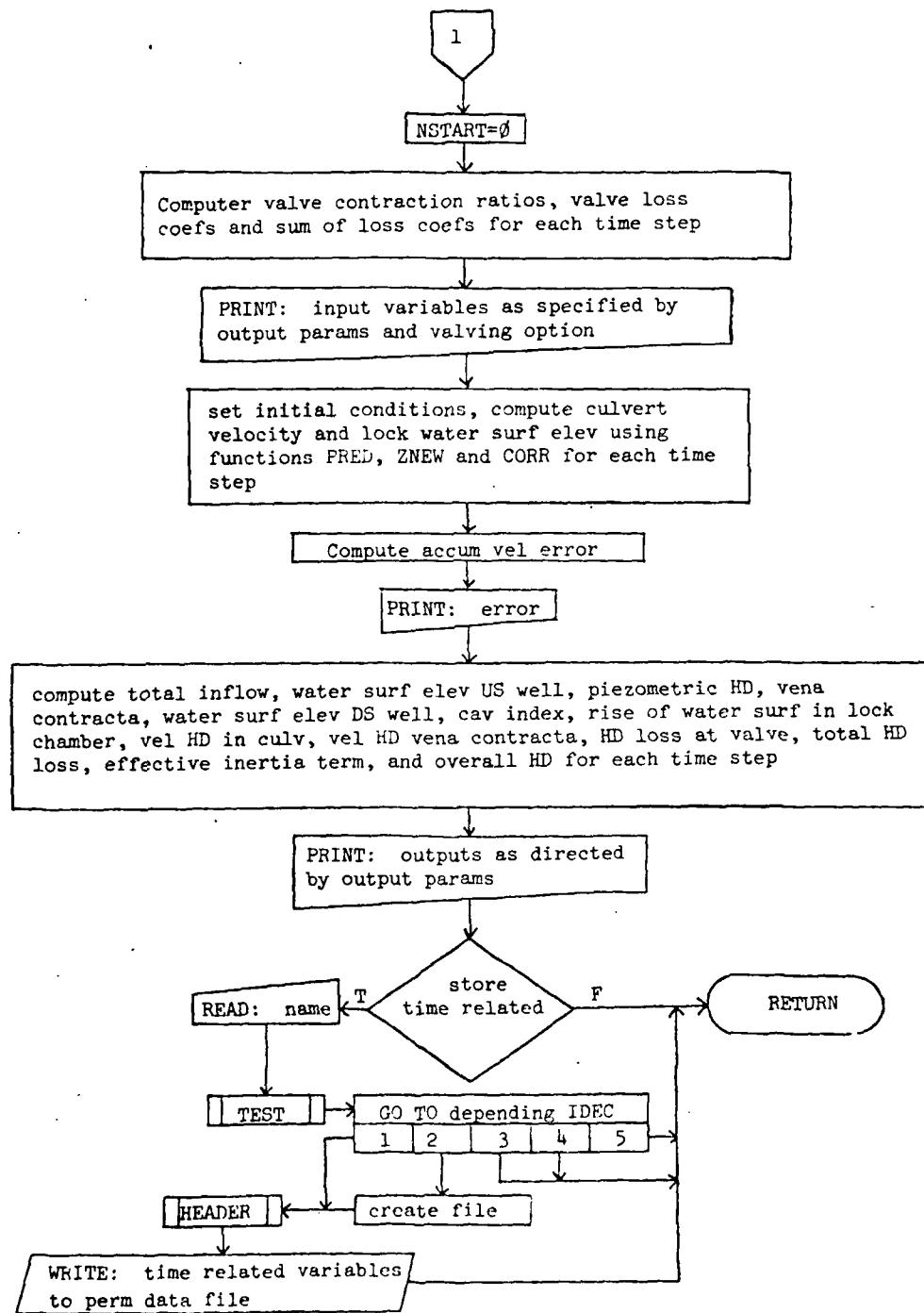
<u>Item (Refer to Figure 1)</u>	<u>Type of Operation</u>	<u>Description</u>
10. Exit loss, $H_{l4} = \frac{K_4 V  V }{2g}$	Filling	Loss at the ports into the lock chamber, $K_4$ is constant
	Emptying	Loss at the downstream exit from the culvert; $K_4$ is constant
11. Inertia "head" $H_e = \frac{L}{g} \frac{dv}{dt}$	Both	The inertia "head" is placed at the downstream end of the culvert (i.e., along with $H_{l4}$ ); L is an effective culvert length, g is the acceleration of gravity, and $dv/dt$ is the rate-of-change of velocity, V, with respect to time, t.

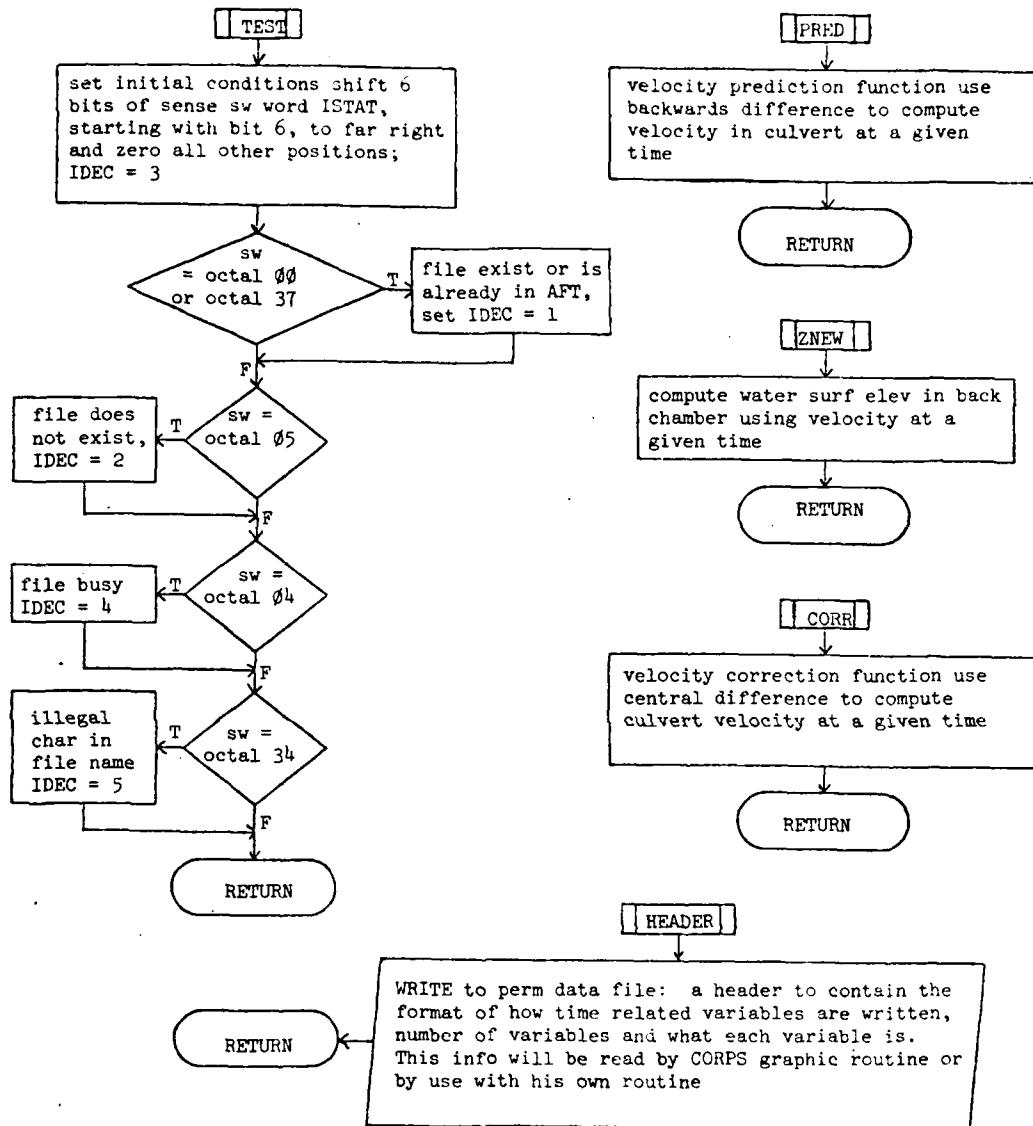
## PART II: COMPUTER FUNCTIONAL DESCRIPTION

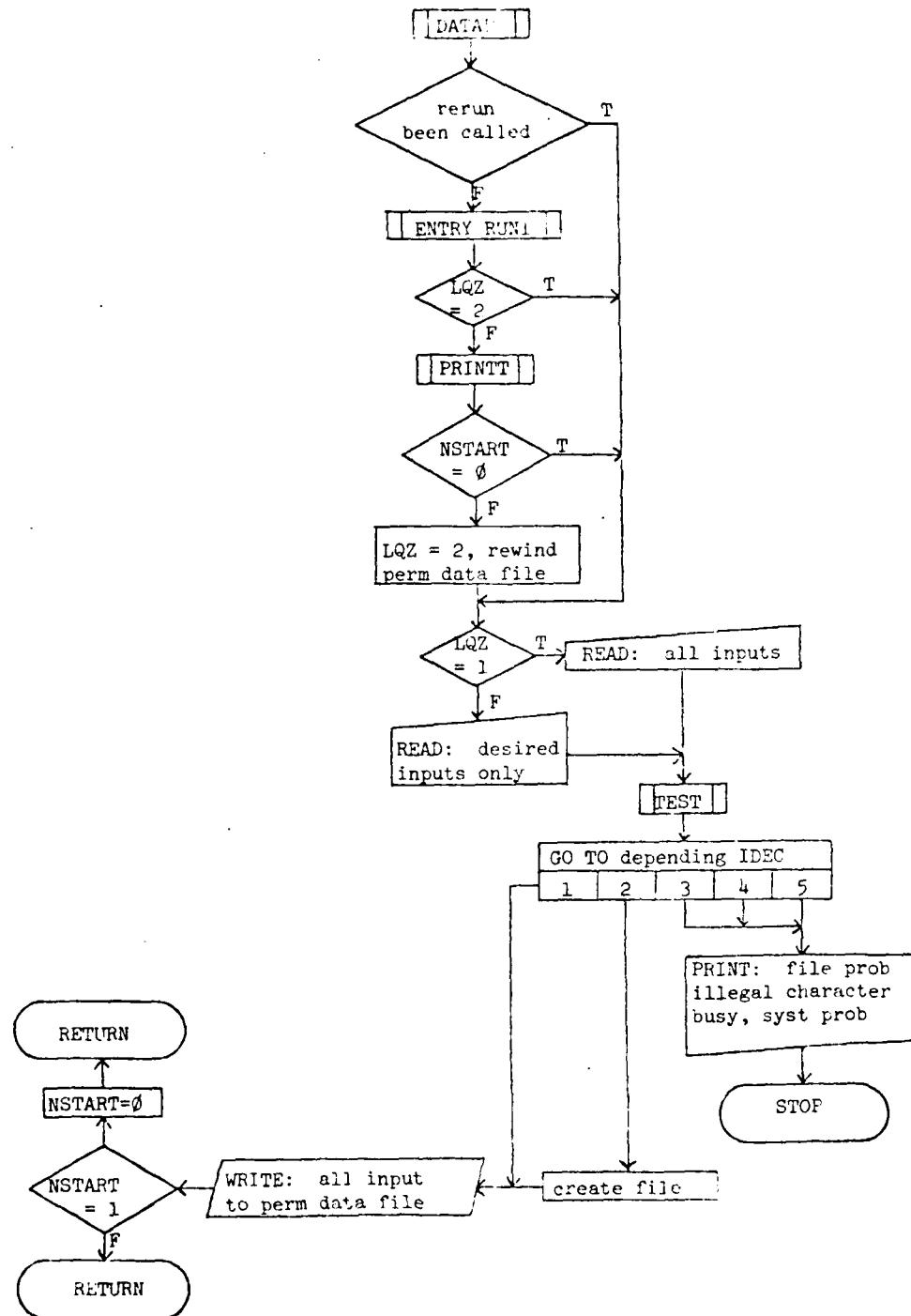
1. REVISION LOG: N/A
2. FUNCTIONAL FLOW CHART:

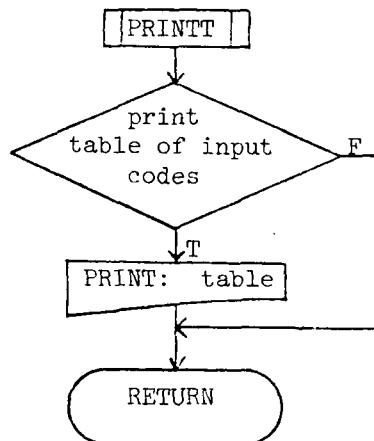
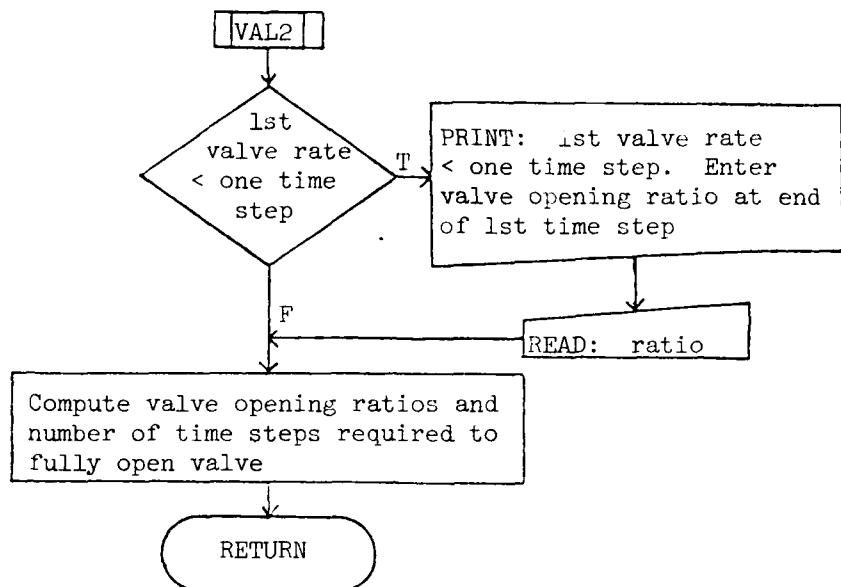












3. EQUIPMENT AND OPERATING SYSTEM: The program was developed on a G635 time-share system in which input/output equipment consisted of a Model 33 remote teletype. It is now operational on the WES G635, Vicksburg, MS; HIS 66/80, Macon, GA; and Boeing CDC, Seattle, WA.

4. INPUT REQUIREMENTS: The required inputs are entered via the user's time-share terminal device in free field format or are read from a permanent input data file. If the inputs are entered through a terminal device, then the input subroutine DATAF will supply all necessary cues and reads for the input data. A user named permanent file will be created by DATAF and the inputs written to it. All the inputs from DATAF are passed to the computation subroutine H5320 via the COMMON statement. If the inputs are entered from an existing data file, then the inputs are read directly by H5320. H5320 also handles all the required output.

5. SECONDARY STORAGE INPUT FORMAT:

a. The following formats are used for the input data file whether it already existed or was created by a run of program H5320.

To write:

56 FORMAT(I3,2F4.0,A35/I3,3F8.3/I3,5F8.3/I3,4F8.3/I3,F5.1,2I4,5I2)

57 FORMAT(I3,10F6.3)

To read:

10100 FORMAT(3X,2F4.0,A35)

10090 FORMAT(3X,3F8.3/3X,5F8.3/3X,4F8.3/3X,F5.1,2I4,5I2)

10110 FORMAT(3X,10F6.3)

Refer to line numbers 24160-24180 and 24200 or 24220 for variable matchup of the above write formats. Refer to 20690-20710 and 20740 or 20760 for read formats. These line numbers are in the source listings on pages 50, 43, and 44. An example data file is:

```
100 1. 2.EXAMPLE 2
102 262.800 169.500 128.000
104 390.000 12.000 14.000 685.400 86.000
106 0.200 0.060 0.180 0.850
108 10.0 31 17 2 1 0 1 3
110 0.120 1.000 0.500 2.000 3.000
```

b. If the user decides to save the time-related output for graphics or other use, then an existing user data file or a newly created user named file is written to in the following manner.

(1) Subroutine HEADER writes all of its header information to the file. This header information is used by the CORPS system for graphics use. If the user wishes to read only the time-related output from the data file, use the format as described in the second line of header information. Refer to line numbers 24900-25020 of the source listing on page 52 for a complete description of header formats.

(2) The time-related variables are written by the following format.

```
10430 FORMAT(I3,3F6.2,F8.3,F9.0,4F8.3/F9.2,2F6.2,F8.2,5F8.2)
```

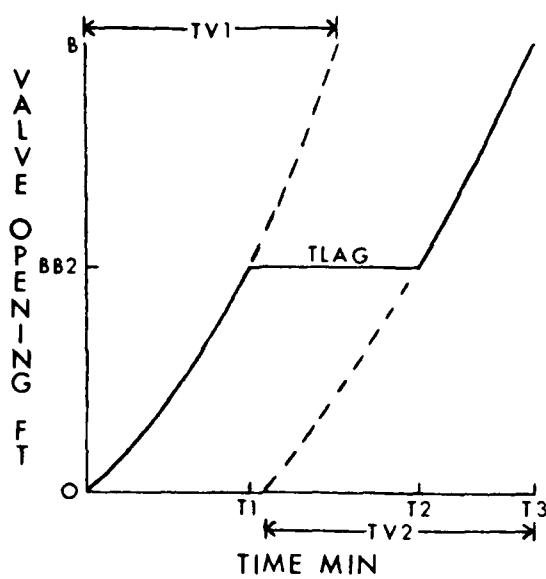
Refer to line numbers 22100-22120 in the source listing on page 46 for variable matchup to the format. An example file is:

H5320

100	0.	0.	0.30	4.00	0.	169.500	262.800	169.500	169.500
9.99	0.	0.	0.	0.	93.30	93.30	0.	93.30	93.30
102	0.17	0.11	0.73	2.11	2190.	169.666	261.969	166.663	170.246
0.88	2.23	6.52	0.66	95.97	84.19	85.04	8.03	93.11	
104	0.33	0.23	0.70	1.47	4453.	170.249	259.363	157.576	172.568
0.71	4.53	13.25	2.73	104.51	79.74	83.26	9.66	92.55	
106	0.50	0.38	0.65	0.98	7548.	171.267	252.926	133.883	177.929
0.39	7.03	22.47	7.84	126.88	75.53	85.64	5.92	91.53	
108	0.67	0.33	0.65	0.98	7737.	172.564	252.427	127.374	179.561
0.32	7.83	23.03	3.23	133.29	79.35	89.97	0.27	98.24	
110	2.53	0.38	0.65	0.98	7699.	173.373	252.523	128.688	182.803
0.33	7.84	22.91	8.15	131.99	78.53	69.09	-0.17	68.93	
112	1.20	0.38	0.65	0.98	7644.	175.175	252.674	130.596	182.826
0.35	7.73	22.75	8.04	130.11	77.46	87.33	-0.20	87.63	
114	1.17	0.33	0.65	0.93	7583.	176.467	252.823	132.537	183.197
0.37	7.72	22.53	7.92	123.20	76.32	86.54	-0.20	86.33	
116	1.33	0.33	0.65	0.93	7531.	177.749	252.970	134.467	184.352
0.40	7.67	22.41	7.30	126.30	75.19	85.25	-0.20	85.05	
118	1.50	0.38	0.65	0.93	7475.	179.022	253.117	136.333	185.554
0.42	7.61	22.25	7.63	124.42	74.07	83.98	-0.20	83.73	
120	1.67	0.33	0.65	0.93	7418.	180.365	253.263	135.235	186.712
0.44	7.55	22.03	7.57	122.55	72.95	82.72	-0.20	82.51	
122	1.33	0.36	0.65	0.93	7362.	181.539	253.407	140.172	187.575
0.46	7.49	21.91	7.45	126.69	71.85	81.40	-0.20	81.26	
124	2.00	0.33	0.65	0.93	7305.	182.793	253.551	142.045	189.023
0.47	7.44	21.74	7.34	118.85	70.75	80.82	-0.20	80.62	
126	2.17	0.33	0.65	0.93	7249.	184.018	253.693	143.984	192.161
0.51	7.33	21.57	7.23	117.32	69.06	78.99	-0.20	78.73	
128	2.33	0.33	0.65	0.93	7193.	185.243	253.834	145.748	191.891
0.53	7.32	21.41	7.12	115.20	65.58	77.70	-0.33	77.56	
130	2.52	0.33	0.65	0.93	7046.	186.450	254.812	150.674	192.244
0.52	7.17	20.95	6.32	114.05	65.09	74.49	1.82	70.35	
132	0.07	0.44	0.66	0.32	5810.	137.743	251.147	150.011	195.684
0.59	3.35	24.42	9.25	110.33	53.40	70.33	4.69	75.06	
134	2.03	0.52	0.67	0.61	9045.	139.250	246.632	140.194	202.131
0.53	9.32	23.72	12.79	113.23	51.56	63.40	5.43	73.54	
136	0.00	0.56	0.69	0.40	11241.	141.028	248.903	143.752	205.814
0.50	11.44	33.45	17.33	114.53	43.57	65.99	5.62	71.77	
138	3.17	0.63	0.72	0.13	12873.	193.074	234.051	144.831	212.447
0.51	13.19	33.31	22.79	112.04	34.74	64.14	5.67	69.73	
140	3.33	2.72	0.74	-0.64	14303.	195.316	226.926	150.735	212.537
0.60	14.65	42.32	23.47	104.66	25.84	62.57	4.97	67.41	
142	3.50	0.77	0.72	-0.27	15629.	197.432	220.467	161.310	226.428
0.77	15.91	40.52	53.06	92.75	17.05	61.19	3.81	64.87	
144	3.67	0.55	0.52	-0.51	16001.	201.653	215.613	174.877	222.447
1.03	16.39	49.11	37.45	78.19	11.49	59.87	2.46	62.14	
146	3.83	2.92	0.56	-0.76	16992.	203.499	212.760	184.141	237.514
1.53	17.30	52.57	39.71	63.33	6.97	53.20	1.26	59.31	
148	4.13	1.02	0.50	-1.00	17201.	206.399	211.502	201.876	240.222
2.16	17.51	51.19	40.70	50.84	4.07	56.57	-0.13	56.42	
150	4.17	1.62	0.28	-1.00	16972.	209.294	213.178	203.937	241.771
2.27	17.22	50.36	39.33	45.02	3.94	54.75	-1.23	53.51	
152	4.33	1.02	0.98	-1.00	16500.	212.130	215.504	200.099	244.837
2.44	16.82	49.17	37.54	46.34	3.75	52.13	-1.53	52.67	
154	4.50	1.60	0.53	-1.00	16037.	214.696	217.949	202.599	245.153
2.64	15.23	47.53	35.60	43.95	3.56	49.43	-1.57	47.90	
156	4.67	1.02	0.90	-1.00	15647.	217.598	220.373	212.474	246.212
2.86	15.93	46.57	33.67	41.57	3.37	46.36	-1.59	45.71	
158	4.30	1.02	0.98	-1.00	15264.	220.885	222.744	215.233	247.119
3.14	15.46	45.25	31.79	39.25	3.13	44.19	-1.62	42.59	
160	5.22	1.02	1.98	-1.00	14760.	222.747	225.842	213.014	245.213
3.26	15.02	43.93	29.97	36.99	3.00	41.65	-1.60	40.85	

6. INPUT DATA DESCRIPTION: The following names are used for the input variables in program H5320.

AAB - 8 char name of perm data file  
DTS - time step, sec  
IDEL1 - output control to valve full open; = 1, print every time step value; = 2, print every 2nd value; = n, print every nth value  
IDEL2 - output control from valve full open to complete solution; = 1, print every time step value; = 2, print every 2nd value; = n, print every nth value  
IPRIN1 - output control for engineering values; = 1, print: conduit and chamber geometry, loss coeffs and elevs; = Ø, no print  
IPRIN2 - output control for head loss distributions; = 1, print; = Ø, no print  
IVALV - type of valving; = 1, point by point; = 2, programmed functions  
M - number of calculated steps desired  
N - number of values of valve opening ratios (point by point)  
RUN - 35 char problem name  
SAG - sag at one-half valve time of the nondimensional valve opening pattern (programmed function)



H5320

TV1 - first valve rate (programmed function), time taken for valve from closed to full open position with no stop, min to full open

T1 - time valve stops initial motion (programmed function), min; no stop,  $T_1 = TV_1$

TLAG - duration of stop (programmed function), min; no stop,  $TLAG = \emptyset$

TV2 - second valve rate (programmed function), time taken for valve from closed to full open position as if no stop, min to full open. If actually no stop,  $TV_2 = TV_1$ , never  $\emptyset$ .

TYPE - type of operation; = 1, filling; = 2, emptying; =  $\emptyset$  stop program

XBB - valve opening ratios (point by point)

XK1 - intake loss coef

XK2 - upstream conduit loss coef

XK3 - downstream conduit loss coef  
XK4 - exit loss coef  
XLL - culvert length, ft  
XL2 - culvert width, ft  
XL3 - culvert height, ft  
XL4 - chamber length, ft  
XL5 - chamber width, ft  
XN - number of culverts  
ZL - lower pool elev, ft-datum  
ZR - culvert roof elev at valve, ft-datum  
ZU - upper pool elev, ft-datum

7. OUTPUT DATA DESCRIPTION: All output is generated within subroutine H5320. It includes the given input data, plus the output data as described in the following variables.

BB2 - valve opening at end of first valve motion (programmed function), ft; Refer to figure given in (6) INPUT DATA DESCRIPTION  
CI - cavitation index  
ERROR - accumulated velocity error,  $ft^2/sec^2$   
H - overall head, ft  
HI - effective inertia, ft  
HLT - total head loss, ft  
HLV - head loss at valve, ft

I - count of the number of time steps at which accumulated velocity error is printed

M1 - number of steps to fill or empty lock chamber, if input M (number of calculated steps desired) is sufficiently large to complete solution

M2 - number of steps to peak overfill or under empty, if input M is sufficiently large to complete solution

NC - number of culverts

Q - total inflow, cfs

RR - rise of water level in lock chamber, ft/min

T3 - valve opening time, min

V - velocity in culvert, fps

VH - velocity head in culvert, ft

VHVC - velocity head at vena contracta, ft

XBB - valve opening ratio

XCC - valve contraction ratio

XKC - equivalent lock coef (based on loss coeffs)

XKT - sum of loss coeffs (including valve) at valve full open

XKV - valve loss coef

XT - time at each calculation, min

XTM - time at extreme elev, min

XTX - time to complete operation, min

Z - lock chamber water surface elev, ft-datum

ZOW - water surface elev in downstream well, ft-datum

ZOT - Lock chamber overfill or empty, ft  
ZUW - water surface elev in upstream well, ft-datum  
ZV - piezometric head elev at vena contracta, ft-datum

8. PROGRAM ERROR MESSAGES:

a. If file name INDATA is entered as the name of your permanent data file and INDATA does not exist, then

NO FILE INDATA. ENTER FILE NAME OR STOP.

is printed from subroutine H5320. This is repeated until an existing file is attached or the reply STOP is entered. If STOP is entered, then control is returned to the main program. Since program only checks file to see if it exists, "be sure" file is your input data file. If not your data file, program will attempt to read bad data and/or abort.

b. If a program or system error occurs in an attempt to attach your data file, then

FILE PROBLEM. CALL FTS 542-2403 AND GIVE THIS NUMBER ISTAT  
(where ISTAT is a 12 digit octal number)

is printed from subroutine H5320. Control is then returned to the main program.

c. If program cannot create or attach an output file for your request of an output data file, then

FILE PROBLEM;ILLEGAL CHAR;BUSY;OR SYSTEM PROBLEM  
OUTPUT VALUES NOT SAVED AS REQUESTED

is printed from subroutine H5320. Control is returned to the main program.

d. If first valve rate is less than one time step, then

YOUR 1ST VALVE RATE IS < ONE TIME STEP  
ENTER VALVE OPENING RATIO AT END OF 1ST TIME STEP

is printed from subroutine VAL2. The ratio is read and program continues to next statement.

e. If program cannot create or attach your input data file, then

FILE PROBLEMS;ILLEGAL CHAR;BUSY;OR SYSTEM PROB.

is printed from subroutine DATAF. Control is returned to the main program.

9. VARIABLE DEFINITIONS:

a. Main program

HFILE - 5 char, name of program; passed to WESLIB, count routine

HACCT

LQZ - equal 1, execute all input cues and reads; equal 2,  
call WESLIB routine RERUN and enter only desired inputs;  
initialized to 1 in main program for first run,  
2 thereafter

LQX - equal 1, print instructions for RERUN; equal 3 no print;  
initialized to 1 in main program

ZZZZ - 2 char; equal RE, rerun; equal ST, stop

b. Subroutine H5320, main computation routine

AAA - 1 char; equal to Y for yes and N for no for response to  
yes or no question

AAB - 8 char, name of permanent data file

AAC - 10 char, used for attaching permanent data file  
AAD - 8 char, name of output file for graphics and/or other use  
AAE - 10 char, used for attaching output file for graphics  
and/or other use  
AR - ratio of total culvert(s) cross-section area to lock  
chamber water surface area  
B - constant = 2.2, used to determine valve loss coef  
BB1 - valve opening ratio at end of first valve motion  
(programmed function)  
BB2 - valve opening at end of first valve motion (programmed  
function) ft  
C - constant = 3.2, used to determine valve loss coef  
CFILE - 25 char, used for creating output file for graphics  
and/or other use  
CI - cavitation index  
CORR - velocity correction FUNCTION subprogram (central differ-  
ence), fps  
D - constant = .65, used to determine valve contraction coef  
DTM - time step, min  
DTS - time step, sec  
E - constant = .9, used to determine valve contraction coef  
ERROR - accumulated velocity error,  $ft^2/sec^2$   
F - constant = .9, used to determine valve contraction coef  
H - overall head, ft

HI - effective inertia term, ft  
HLT - total head loss, ft  
HLV - head loss at valve, ft  
HLL - intake head loss, ft  
HL2 - upstream conduit head loss, ft  
HL3 - downstream conduit head loss, ft  
HL4 - exit head loss, ft  
I - count of the number of time steps  
IDEC - switch equal to:  
      1 - file exist or is in AFT      2 - file nonexistent  
      3 - file problem                    4 - file busy  
      5 - illegal char in file name  
IDELL - output control to valve full open; = 1, print every time  
        step value; = 2, print every 2nd value; = n, print every  
        nth value  
IDEL2 - output control from full open to completed solution;  
        = 1, print every time step value; = 2, print every 2nd  
        value; = n, print every nth value  
IPRIN1 - output control for engineering input variables; = 1,  
        print; =  $\emptyset$ , no print  
IPRIN2 - output control for loss distribution; = 1, print; =  $\emptyset$ ,  
        no print  
IVALV - type of valving; = 1, point by point; = 2, programmed  
        function

IVALL - switch variable set to  $\emptyset$  to be passed to subroutine  
DATAF

IVAL2 - switch variable set to  $\emptyset$  to be passed to subroutine  
DATAF

KK - switch variable set to  $\emptyset$  to be passed to subroutine  
DATAF

LINE - line numbers in output file for graphics and/or other  
use

M - total number of calculated steps desired

M1 - number of steps to fill or empty lock chamber if M is  
sufficiently large to complete solution

M2 - number of steps to peak overfill or under empty if M  
is sufficiently large to complete solution

M3 - switch; omit corrector sequence for low velocity flows

N - number of valve opening ratios

NC - number of culverts

NSTART - switch; = 1 if input is first read from permanent data  
file, else =  $\emptyset$

PRED - velocity prediction FUNCTION subprogram (backward  
difference), fps

Q - total inflow, cfs

RR - rise of water in lock chamber, fpm

RUN - 35 char problem name

SAG - sag at one-half valve time of the nondimensional valve opening pattern (programmed function)

T1 - time valve stops initial motion (programmed function), min

TLAG - duration of stop (programmed function), min

T3 - valve opening time, min

TV1 - first valve rate (programmed function), time taken for valve from closed to full open with no stop, min to full open

TV2 - second valve rate (programmed function), time taken for valve from closed to full open as if no stop, min to full open. If actually no stop, TV2 = TV1, never  $\emptyset$

TYPE - type of operation; = 1, fill; = -1, empty; =  $\emptyset$ , stop program

V - velocity in culvert, fps

VH - velocity head in culvert, ft

VHVC - velocity head at vena contracta, ft

XBB - valve opening ratios

XCC - valve contraction ratios

XK - sum of loss coeffs (including valve)

XKC - equivalent lock coef (based on loss coeffs)

XKT - sum of loss coeffs (including valve) at valve full open

XKV - valve loss coef

XK1 - intake loss coef  
XK2 - upstream loss coef  
XK3 - downstream loss coef  
XK4 - exist loss coef  
XL1 - culvert length, ft  
XL2 - culvert width, ft  
XL3 - culvert height, ft  
XL4 - chamber length, ft  
XL5 - chamber width, ft  
XN - number of culverts  
XT - time at each calculation, min  
XTM - time at extreme elev, min  
XTX - time to complete operation, min  
YY - working storage  
Z - lock chamber water surface elev, ft-datum  
ZCHEC - lock chamber water surface elev at time  $t_{i+1}$ , ft-datum  
ZOW - water surface elev in downstream well, ft-datum  
ZNEW - lock chamber water surface FUNCTION subprogram to  
evaluate successive elevs, ft-datum  
ZL - lower pool water surface elev, ft-datum  
ZOT - lock chamber overfill or under empty, ft  
ZR - culvert roof elev at valve, ft-datum  
ZREF - upper pool water surface elev, filling; lower pool water  
surface elev, emptying; ft-datum

ZU - upper pool water surface elev, ft-datum

ZUW - water surface elev in upstream well, ft-datum

ZV - piezometric head elev at vena contracta, ft-datum

c. Function PRED, velocity prediction function; uses backwards difference to evaluate the culvert velocity at a given time.

AR - ratio of total culvert(s) cross-section area to lock chamber water surface area

DTS - time step, sec

PRED - symbolic name of single valued function used as the return for the output value to the calling program, fps

TYPE - type of operation; = 1, filling; = -1, emptying

VST - culvert velocity at time  $t_i$  or  $t_{i+1}$ , fps

XB - working storage

XC - working storage

XKF - sum of loss coeffs (including valve) at time  $t_{i+1}$  or  $t_{i+2}$

XL1 - culvert length, ft

ZREF - upper pool water surf elev, filling; lower pool water surface elev, emptying; ft-datum

ZST - lock chamber water surface elev at time  $t_i$  or  $t_{i+1}$ , ft-datum

d. Function COOR, velocity correction function; uses central difference to evaluate the culvert, velocity at a given time.

AR - ratio of total culvert(s) cross-section area to lock chamber water surface area

CORR - symbolic name of single valued function used as the return for the output value to the calling program, fps

DTS - time step, sec

TYPE - type of operation; = 1, filling; = -1, emptying

VAH - culvert velocity at time  $t_{i+1}$  or  $t_{i+2}$ , fps

VST - culvert velocity at time  $t_{i-1}$  or  $t_i$ , fps

XB - working storage

XC - working storage

XKF - sum of loss coeffs (including valve) at  $t_{i-1}$  or  $t_i$

XLL - culvert length, ft

ZREF - upper pool water surface elev, filling; lower pool water surface elev, emptying; ft-datum

ZST - lock chamber water surface elev at time  $t_{i-1}$  or  $t_i$ , ft-datum

e. Function ZNEW, evaluate water surface elev in lock chamber using velocity at a given time.

AR - ratio of total culvert(s) cross-section area to lock chamber water surface area

DTS - time step, sec

TYPE - type of operation; = 1, filling; = -1, emptying

VF - culvert velocity at time  $t_{i+1}$ , fps

VST - culvert velocity at time  $t_i$ , fps

ZNEW - symbolic name of single valued function used as the  
return for the output value to the calling program,  
ft-datum

ZST - lock chamber water surface elev at time  $t_i$ , fps

f. Subroutine TEST, determine status codes returned by file system  
for an attach operation.

IDEC - decimal value for status codes; IDEC =  
1 - file exist or is in AFT  
2 - file nonexistent  
3 - file problem  
4 - file busy  
5 - illegal char in file name

ISTAT - status code (12 digit octal number) returned by file  
system; converted to decimal as represented by IDEC

ITEST - 2 digit octal number = 00, 04, 05, 34 or 37; used as  
test against status code ISTAT to determine IDEC value

g. Subroutine VAL2, called if valve option is programmed functions.

Computes valve opening ratios and number of time steps to fully open  
valve.

A - sag at one-half valve time of the nondimensional valve  
opening pattern

BB1 - valve opening ratio at end of 1st time step

DTM - time step, min

DTS - time step, sec

N - number of values of valve opening ratios

PI - constant = 3.141593  
 TLAG - duration of stop, min  
 TV1 - first valve rate, time taken for valve from closed to  
       full open with no stop, min to full  
 TV2 - second valve rate, time taken for valve from closed to  
       full open as if no stop, min to full. If actually no  
       stop, TV2 = TV1, never =  $\emptyset$   
 T1 - time valve stops initial motion, min  
 T2 - time at which valve motion starts following the partial-  
       open stop, min  
 T2N - working storage  
 T2S - working storage  
 XBB - valve opening ratios  
 XT - time at each calculated ratio, min

h. Subroutine DATAF, supports inputs via teletype and rerun option.

All variables are as described in subroutine H5320 except:

CFILE - 24 char, used for creating a permanent input data file  
 LQZ - equal 1, execute all input cues and reads; equal 2, call  
       WESLIB routine RERUN and enter only desired inputs

IVAL1 and

IVAL2 - switch pair for setting value of rerun option LQZ

IVAL1 and IVAL2 sets LQZ

1	$\emptyset$	2
$\emptyset$	1	2

all other conditions, switch ignored

KK - switch for rerun option LQZ; KK = 1 sets LQZ = 2; any other value of KK, switch ignored

KKK - total number of inputs, passed to RERUN

JKL - direct return from RERUN to desired input read

LQX - equal 1, print instructions from RERUN; equal 3, no print

i. Subroutine PRINTT, provides a listing of input variables at the teletype during a run of program H5320.

AAA - 1 char; = N, no print listing; = Y, print

j. Subroutine HEADER, called if desire output stored for graphics and/or other use. HEADER writes a heading to the output file which contains the format the file was written in, the number of time related variables written and what each variable is, and the type of axis to graph the data on. The time related variables are then written under the heading.

M - number of calculated steps

10. EXAMPLE CASE: Determine the hydraulic performance of a lock culvert system during a filling operation.

a. Input Data:

Type operation	1
Problem title	Example 1
No. culverts	2
Upper pool elev, ft-datum	262.80
Lower pool elev, ft-datum	169.50
Culvert roof elev, ft-datum	128.00
Culvert length, ft	390.00
Culvert width, ft	12.00
Culvert height, ft	14.00
Chamber length, ft	685.40

Chamber width, ft	86.00
Intake loss coef	0.20
U. S. loss coef	0.06
D. S. loss coef	0.18
Exit loss coef	0.85
Time step, sec	10.00
No. of stepped values	73
Type of valving	2
Valve sag at 1/2 open time	0.12
First valve rate, min	4.00
Time valve stops motion, min	4.00
Duration of stop, min	0.00
Final valve rate, min	4.00
Output control, engr inputs	1
Output control, loss distribution	1
First output rate	1
Final output rate	3

b. Output:

EXAMPLE 1

CONDIT GEOMETRY: LENGTH = 390.0 FT. WIDTH = 12.0 FT.  
HEIGHT = 14.0 FT. N = 2-CULVERT OPERATION)

CHAMBER GEOMETRY: LENGTH = 685.4 FT. WIDTH = 86.0 FT.

LOSS COEFFICIENT: INTAKE 0.200  
UPSTREAM CONDIT 0.060  
DOWNSTREAM CONDIT 0.180  
MANIFOLD 0.850  
TOTAL (VALVE OPEN) 1.390      LOCK COEF. = 0.849

ELEVATIONS: UPSTREAM POOL 262.80  
LOWER POOL 169.50  
CULVERT ROOF 123.00

VALVE OPENS AT 4.00-MIN. RATE FOR 4.00 MINUTES

ACC."EL. EPPOP TO I = 58 IS 0.00595  
ACC."EL. EPPOP TO I = 64 IS 0.00598

LOCK FILLS TO UPSTREAM POOL IN 9.56 MINUTES  
EXTREME ELEVATION AT TIME = 10.50 MINUTES  
MAY COMPUTED OVERFALL = 1.57 FT.

VALVE PARAMETERS					ELEVATIONS (FT-DATUM)						
TIME	OPEN.	CONT.	LOSS	TOTAL	LOCK	WELL	VALVE	WELL	CAV. F.P.		
(M)	PATIO	COEF.	COEF.	INFLOW	CFS						
0.	0.00	0.80	10000.00	0.	169.50	262.80	169.50	169.50	9.99		
0.17	0.03	0.80	2147.81	556.	169.55	262.75	164.34	169.53	0.84		
0.33	0.05	0.79	531.46	1115.	169.69	262.58	163.62	169.83	0.83		
0.50	0.08	0.79	232.25	1631.	169.93	262.31	162.38	170.26	0.80		
0.67	0.11	0.73	127.64	2258.	170.26	261.92	160.56	170.86	0.77		
0.83	0.14	0.76	79.36	2848.	170.69	261.39	158.07	171.64	0.72		
1.00	0.17	0.75	53.25	3452.	171.23	260.74	154.80	172.62	0.67		
1.17	0.20	0.73	37.63	4075.	171.87	259.92	150.37	173.81	0.60		
1.33	0.23	0.70	29.23	4585.	172.60	259.16	151.25	175.06	0.61		
1.50	0.26	0.63	22.63	5147.	173.43	258.21	148.24	176.52	0.57		
1.67	0.30	0.65	17.28	5799.	174.35	256.97	140.57	173.29	0.47		
1.83	0.34	0.65	13.00	6554.	175.40	255.36	140.19	180.42	0.46		
2.00	0.38	0.65	9.64	7424.	176.59	253.25	138.10	183.03	0.44		
2.17	0.42	0.66	7.04	8414.	177.93	250.53	134.95	186.21	0.40		
2.33	0.47	0.67	5.06	9520.	179.45	247.09	138.43	190.05	0.36		
2.50	0.51	0.68	3.59	10726.	181.17	242.86	128.59	194.62	0.33		
2.67	0.56	0.69	2.51	11994.	183.10	237.87	127.25	199.92	0.31		
2.83	0.61	0.71	1.73	13269.	185.24	232.29	128.43	205.82	0.32		
3.00	0.67	0.73	1.18	14477.	187.59	226.48	132.81	212.10	0.37		
3.17	0.72	0.75	0.80	15542.	190.14	220.94	140.53	213.38	0.46		
3.33	0.77	0.73	0.53	16400.	192.85	216.19	151.06	224.29	0.60		
3.50	0.83	0.81	0.35	17016.	195.68	212.62	163.36	229.54	0.82		
3.67	0.89	0.84	0.23	17389.	198.60	210.40	176.21	233.95	1.12		
3.83	0.94	0.87	0.15	17542.	201.57	209.47	188.57	237.54	1.52		
4.00	1.00	0.90	0.10	17548.	204.54	209.43	199.50	240.54	2.03		
4.50	1.00	0.90	0.10	16364.	213.19	216.39	207.75	244.50	2.51		
5.00	1.00	0.90	0.10	15035.	221.18	223.62	216.33	247.61	3.20		
5.50	1.00	0.90	0.10	13704.	228.49	230.25	224.19	250.45	4.10		
6.00	1.00	0.90	0.10	12373.	235.13	236.27	231.33	253.03	5.30		
6.50	1.00	0.90	0.10	11042.	241.09	241.67	237.74	255.34	6.96		
7.00	1.00	0.90	0.10	9711.	246.37	246.46	243.41	257.40	9.36		
7.50	1.00	0.90	0.10	8380.	250.97	250.63	248.36	259.18	9.99		
8.00	1.00	0.90	0.10	7049.	254.90	254.19	252.59	260.71	9.99		
8.50	1.00	0.90	0.10	5718.	258.15	257.13	256.08	261.97	9.99		
9.00	1.00	0.90	0.10	4387.	260.72	259.47	253.84	262.97	9.99		
9.50	1.00	0.90	0.10	3056.	262.61	261.18	260.88	263.71	9.99		
10.00	1.00	0.90	0.10	1725.	263.83	262.28	262.19	264.18	9.99		
10.50	1.02	0.90	0.10	394.	264.37	262.77	262.77	264.39	9.99		
11.00	1.00	0.90	0.10	-833.	264.24	262.73	262.63	264.16	9.99		
11.50	1.00	0.90	0.10	-1446.	263.64	262.59	262.30	263.39	9.99		
12.00	1.00	0.90	0.10	-1393.	262.89	262.60	262.34	262.67	9.99		

RATE (F/M)	PISE (F/S)	VEL. AREA	REF. CONT.	VEL HDS(F)		DIFFERENTIAL HDS(F)		
				VEA	VEL	VALVE	TOTAL	INEPTIA
0.	0.	0.	0.	93.300	93.300	0.	93.300	93.300
0.17	0.566	1.654	0.042	98.448	91.189	91.243	2.009	93.253
0.33	1.135	3.318	0.171	99.134	90.861	91.082	2.029	93.111
0.50	1.712	5.004	0.389	100.317	90.311	90.813	2.061	92.874
0.67	2.299	6.721	0.701	102.058	39.532	90.437	2.102	92.540
0.83	2.899	8.475	1.115	104.441	88.516	89.955	2.151	92.107
1.00	3.513	10.273	1.639	107.573	87.254	89.368	2.212	91.572
1.17	4.148	12.128	2.284	111.841	85.940	88.887	2.043	90.934
1.33	4.667	13.646	2.891	110.794	84.529	88.259	1.932	90.199
1.50	5.239	15.319	3.644	113.615	82.475	87.175	2.183	89.374
1.67	5.903	17.259	4.625	121.023	79.929	85.895	2.536	88.445
1.83	6.672	19.507	5.909	121.069	76.330	84.452	2.929	87.397
2.00	7.557	22.095	7.581	122.732	73.064	82.843	3.351	86.212
2.17	8.564	25.040	9.736	125.322	68.514	81.074	3.778	84.863
2.33	9.690	28.333	12.465	128.075	63.039	79.169	4.167	83.347
2.50	10.918	31.921	15.822	130.096	56.760	77.171	4.460	81.630
2.67	12.209	35.697	19.737	130.402	49.613	75.139	4.584	79.702
2.83	13.507	39.491	24.216	128.069	41.838	73.127	4.475	77.560
3.00	14.736	43.086	28.827	122.492	33.988	71.174	4.096	75.206
3.17	15.820	46.255	33.222	113.634	26.416	69.273	3.465	72.660
3.33	16.693	43.809	36.992	102.126	19.654	67.374	2.653	69.950
3.50	17.321	50.644	39.826	39.090	14.032	65.408	1.783	67.116
3.67	17.701	51.753	41.590	75.779	9.662	63.313	0.943	64.197
3.83	17.856	52.209	42.326	63.230	6.457	61.058	0.287	61.234
4.00	17.863	52.227	42.355	52.290	4.236	58.874	-0.538	58.257
4.50	16.657	48.702	36.830	45.469	3.683	51.194	-1.583	49.610
5.00	15.304	44.748	31.092	38.386	3.109	43.218	-1.599	41.619
5.50	13.950	40.736	25.831	31.390	2.583	35.905	-1.599	34.306
6.00	12.595	36.825	21.057	25.996	2.106	29.269	-1.599	27.670
6.50	11.240	32.863	16.770	20.704	1.677	23.310	-1.599	21.711
7.00	9.885	28.902	12.971	16.013	1.297	18.029	-1.599	16.430
7.50	8.530	24.940	9.659	11.924	0.966	13.426	-1.599	11.826
8.00	7.175	20.979	6.834	8.437	0.683	9.499	-1.599	7.900
8.50	5.820	17.017	4.497	5.552	0.450	6.250	-1.599	4.651
9.00	4.465	13.056	2.647	3.268	0.265	3.679	-1.599	2.080
9.50	3.110	9.094	1.234	1.586	0.128	1.785	-1.599	0.186
10.00	1.756	5.133	0.409	0.505	0.041	0.569	-1.599	-1.031
10.50	0.401	1.171	0.021	0.026	0.002	0.030	-1.599	-1.570
11.00	-0.843	-2.430	0.096	0.096	0.010	0.133	-1.175	-1.444
11.50	-1.472	-4.304	0.238	0.288	0.029	0.400	-0.299	-0.836
12.00	-1.417	-4.144	0.267	0.267	0.027	0.371	2.649	-0.093

DO YOU NEED TO STOP THE OUTPUT IN A DATA FILE? Y OR N

=N

ENTER PEPIN OR STOP

=PEPIN

PEPIN OPTION PEPNITS YOU TO CHANGE ANY OR ALL INPUT VAPIABLES.

AT &gt;&gt;&gt;= QUE TYPE IN THE TWO LETTERS(AA,AB,ETC.) CORRESPONDING TO THE VAPIAELLES YOU WISH TO CHANGE. THEN AT NEXT = QUE, ENTER THE NUMERICAL VALUE. TO TERMINATE DATA ENTPY, TYPE A CARRIAGE PETHRN AT &gt;&gt;&gt;= QUE.

```

>>>
=AB
AB-ENTER YOUR PROBLEM NAME
=EXAMPLE 2
>>>
=AQ
AQ-ENTER TOTAL NO. OF CALC. STEPS DESIRED
=31
>>>
=AV
AV-ENTER FIRST VALVE RATE
=1
>>>
=AV
AV-ENTER TIME VALVE STOPS MOTION(MINUTES)
=.5
>>>
=AX
AX-ENTER DURATION OF STOP(MINUTES)
=2
>>>
=AY
AY-ENTER FINAL VALVE RATE
=3
>>>
=FA
FA-ENTER 2ND OUTPUT CONTROL; 1=DO, 0=DO NOT PRINT
=0
>>>
=

```

## EXAMPLE 2

CONDUIT GEOMETRY: LENGTH = 392.0 FT. WIDTH= 12.0 FT.  
HEIGHT= 14.0 FT. N= 2-CULVERT OPERATION

CHAMBER GEOMETRY: LENGTH = 635.4 FT. WIDTH = 86.0 FT.

LOSS COEFFICIENT: INTAKE	0.200
UPSTREAM CONDUIT	0.660
DOWNTSTREAM CONDUIT	0.180
MANIFOLD	0.350
TOTAL (VALVE OPEN)	1.390
LOCK COEF.	=0.843

ELEVATIONS: UPPER POOL 262.80  
LOWER POOL 164.50  
CULVERT ROOF 123.00

VALVE OPENS AT 1.00-MIN. RATE FOR 0.50 MINUTES  
VALVE HOLDS FOR 2.00-MIN. AT 5.32FT.;  
THEN OPENS AT 3.00-MIN. RATE TO FULL OPEN  
TOTAL VALVE TIME = 4.17-MIN. (N= 26)

ACC.VEL. ERROR TO I= 31 IS 3.01400  
ACC.VEL. ERROR TO I= 31 IS 0.01400  
LOCK OPERATION IS NOT COMPLETE  
LOCK DOES NOT COMPLETE OVERPAVEL

VALVE PARAMETERS						ELEVATIONS (FT-DAIIM)						
TIME	OPEN.	CONT.	LOSS	TOTAL	CFS	LOCK	US	VALVE	PIEZ.	HD	DS	VALVE
(M)	RATIO	COEF.	COEF.	INFLOW		CHAMBER	WELL	WELL				WELL
0.	0.	0.80	10000.00	0.	169.50	262.80	169.50	169.50	9.99			
0.17	0.11	0.78	127.64	2190.	169.69	261.97	166.66	170.25	0.88			
0.33	0.23	0.70	29.23	4453.	170.25	259.36	157.58	172.57	0.71			
0.50	0.33	0.65	9.64	7548.	171.27	252.93	133.88	177.93	0.39			
0.67	0.38	0.65	9.64	7737.	172.56	252.43	127.37	179.56	0.32			
0.83	0.38	0.65	9.64	7699.	173.87	252.53	128.69	180.80	0.33			
1.00	0.38	0.65	9.64	7644.	175.17	252.67	130.60	182.01	0.35			
1.17	0.38	0.65	9.64	7588.	176.47	252.82	132.54	183.20	0.37			
1.33	0.38	0.65	9.64	7531.	177.75	252.97	134.47	184.38	0.40			
1.50	0.38	0.65	9.64	7475.	179.02	253.12	136.38	185.55	0.42			
1.67	0.38	0.65	9.64	7418.	180.29	253.26	138.29	186.72	0.44			
1.83	0.38	0.65	9.64	7362.	181.54	253.41	140.17	187.88	0.46			
2.00	0.38	0.65	9.64	7305.	182.78	253.55	142.05	189.02	0.48			
2.17	0.38	0.65	9.64	7249.	184.02	253.69	143.90	190.16	0.51			
2.33	0.38	0.65	9.64	7193.	185.24	253.83	145.75	191.29	0.53			
2.50	0.38	0.65	9.64	7040.	186.45	254.21	150.67	192.24	0.60			
2.67	0.44	0.66	6.32	8200.	187.74	251.15	150.01	195.60	0.59			
2.83	0.50	0.67	4.03	9645.	189.26	246.68	146.19	200.13	0.53			
3.00	0.56	0.69	2.51	11241.	191.03	240.90	143.75	205.80	0.50			
3.17	0.63	0.72	1.52	12873.	193.07	234.08	144.83	212.45	0.51			
3.33	0.70	0.74	0.91	14388.	195.39	226.93	156.73	219.59	0.60			
3.50	0.77	0.78	0.53	15629.	197.93	220.47	161.31	226.49	0.77			
3.67	0.85	0.82	0.31	16501.	200.66	215.61	174.88	232.49	1.08			
3.83	0.92	0.86	0.18	16992.	203.50	212.76	189.14	237.25	1.53			
4.00	1.00	0.90	0.10	17201.	206.40	211.52	201.98	240.99	2.16			
4.17	1.00	0.90	0.10	16922.	209.29	213.18	203.94	242.77	2.27			
4.67	1.00	0.90	0.10	15647.	217.59	220.37	212.47	246.21	2.86			

DO YOU NEED TO STORE THE OUTPUT IN A DATA FILE? Y OR N

=Y

ENTER A 5-LETTER FILE NAME

=DLK1

YOUR OUTPUT VALUES ARE STORED IN FILE DLK1

ENTER REPUN OR STOP

=STOP

REF: ER 1110-1-10 - ENGINEERING AND DESIGN - Engineering and Computer Program Library Standards and Documentation, Appendix C

PART III: FILE DOCUMENTATION

1. REVISION LOG: N/A
2. TITLE: H5320 - Lock Filling and Emptying - Symmetrical Systems
3. SOURCE PROGRAM LISTINGS: See pages 41-52
4. NUMERICAL AND LOGICAL ANALYSIS: A finite difference scheme is used to determine the flow rate through the culverts and water surface elevation in the chamber during a lock operation.
5. SUBROUTINES NOT DOCUMENTED IN ABSTRACT: None
6. MISCELLANEOUS: The program is part of the CORPS computer system. CORPS is an acronym standing for Conversationally Oriented Real-Time Program-Generating System. The program is now operational on the WES G635, Vicksburg, MS; HIS 66/80, Macon, GA, and Boeing CDC, Seattle, WA. The source listing on page 41 contains the first line run command and brief for H5320. This first line run command runs the binary H5320B of the source listing on pages 42-52 (Fortran source of H5320) and attaches the WESLIB routines HACCT and RERUN.

H5320

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H5320

0001\*#P1N VESLIE/H5320B, P;VESLIB/PERIN, P;VESLIB/HACCT, R  
0300 03NO BPIEF  
0999\*06FINISH

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H5320S

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00001*#RUN *=;WESLIB/H5320B,R(NOGO)
10000 CHARACTER*5 HFILE
10010 COMMON LQZ,LQX
10020 HFILE=5HH5320
10030 LQZ=1;LQX=1
10040 PRINT 10
10050 10 FORMAT(/"H5320 - LOCK FILLING AND EMPTYING-SYMMETRICAL SYSTE
10060 &MS"//)
10070 15000 CONTINUE
10080 CALL HACCT(HFILE)
10090 IF(LQZ.EQ.1) CALL H5320($16000)
10100 GO TO(20,30),LQZ
10110 30 CALL DATAF($16000)
10120 CALL MAIN1($16000)
10130 PRINT," "
10140 20 LQZ=2
10150 CHARACTER ZZZZZZ*2
10160 16000 PRINT, "ENTER PEPIN OR STOP"
10170 READ 16001, ZZZZZZ
10180 16001 FORMAT(A2)
10190 IF(ZZZZZZ.EQ.2HRE) GO TO 15000
10200 IF(ZZZZZZ.EQ.2HST) GO TO 20000
10210 PRINT,"ERPOP *** RETYPE"
10220 GO TO 16000
10230 20000 STOP;END
20000 SUBROUTINE H5320(*)
20010 COMMON LQZ,LQX,XBB(201),TYPE,RIN,XN,ZU,ZL,ZP,XL1,XL2,XL3,XL4,XL5,
20020&XK1,XK2,XK3,XK4,DTS,M,I VALU,N,EB1,AAB,TV1,T1,TLAG,TV2,AAC,SAG,IPR
20030&IN1,IPPIN2,I DEL1,I DEL2,NSTAPT,KK,I VAL1,I VAL2,LINE(201)
20040 DIMENSION XT(201),XKV(201),XCC(201),Q(201),PP(201),Z(201),ZIW(201)
20050&ZV(201),ZDV(201),V(201),VH(201),HL1(201),HL2(201),HLV(201),HL3(20
20060&1),HL4(201),HLT(201),HI(201),H(201),XK(201),CI(201),VHVC(201)
20070 CHARACTER RIN*35,AAA*1,AAB*8,AAC*10,AAD*8,AAE*10,CFILE*25
20080 DATA B,C,D,E,F,CI(1),XKV(1)/2.2,3.2,.65,.8,.9,9.99,10000.0/
20090 KK=0;I VAL1=0;I VAL2=0
20100 10090 FORMAT(3X,3F8.3/3X,5F8.3/3X,4F8.3/3X,F5.1,2I4,5I2)
20110 10100 FORMAT(3X,2F4.0,A35)
20120 10110 FORMAT(3X,10F6.3)
20130 10120 FORMAT("CONDUIT GEOMETRY: LENGTH = ",F7.1," FT. WIDTH= ",
20140&F5.1," FT.",/,13X,"HEIGHT=",F5.1," FT. N=",I2,
20150&"-CULVERT OPERATION"),//,"CHAMBER GEOMETRY:", 
20160&" LENGTH =",F6.1," FT. WIDTH =",F5.1," FT.",//,"LOSS ", 
20170&"COEFFICIENT: INTAKE",F7.3,/,9X,"UPSTREAM CONDUIT",F7.3,/, 
20180&7X,"DOWNSTREAM CONDUIT",F7.3,/,17X,"MANIFOLD",F7.3,/,3X,"TOTAL "
20190&("VALVE OPEN"),F7.3," LOCK COEF. =",F5.3,/, 
20200&"ELEVATIONS: UPPER POOL",F7.2,/,13X,"LOWER POOL", 
20210&F7.2,/,11X,"CULVERT POOF",F7.2) 
20220 10210 FORMAT(//,"VALVE OPENS AT",F7.2,"-MIN. RATE FOR",F7.2, 
20230&" MINUTES") 
20240 10230 FORMAT("VALVE HOLDS FOR",F6.2,"-MIN. AT",F6.2,"FT.",",/

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H5320S CONT.

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20250&"THEN OPENS AT",F6.2,"-MIN. RATE TO FULL OPEN",/
20260&"TOTAL VALVE TIME =",F6.2,"-MIN. (N=",I3,")"//)
20270 10260 FORMAT(//,"SPECIAL VALVING, TIME=",F7.2,"-MIN."//)
20280 10270 FORMAT("EXTREME ELEVATION AT TIME =",/
20290&F6.2," MINUTES",/,"MAX COMPUTED OVERTRAVEL =",F5.2," FT.")/
20300 10290 FORMAT(//,6X,"VALVE PARAMETERS",15X,"ELEVATIONS (FT-DATUM)"//)
20310&"TIME OPEN. CONT. LOSS TOTAL LOCK US VALVE PIEZ.HD DS",/
20320&" VALVE"/" (M) RATIO COEF. COEF. INFLOW CHAMBER WELL"
20330&," VALVE WELL",/,"CFS",33X,"CAV.PAR.")/
20340 10330 FORMAT(F6.2,2F5.2,F9.2,F7.0,4F8.2,F5.2)
20350 10340 FORMAT(9X,"RATE",10X,"VEL HDS(F)",10X,"DIFFERENTIAL HDS(F)"//)
20360&,9X,"RISE VEL. REF. VENA VALVE TOTAL INERTIA OVERALL"//)
20370&,8X,"(F/M) (F/S) AREA CONT.",11X,"LOSS"/)
20380 10370 FORMAT(F6.2,3F7.3,3F8.3,F7.3,F8.3)
20390 10380 FORMAT(//,"LOCK EMPTIES TO LOWER POOL IN ",F5.2," MINUTES")
20400 10390 FORMAT(//,"LOCK FILLS TO UPPER POOL IN ",F5.2," MINUTES")
20410 10400 FORMAT("ACC.VEL. ERROR TO I =",I3," IS",F10.5)
20420 10410 FORMAT(//)
20430 10420 FORMAT(A1,A8,A1)
20440 10430 FORMAT(I3,3F6.2,F9.2,F7.0,4F7.2,4F6.2,5F7.2)
20450 NSTART=0
20460 PRINT,"DO YOU HAVE A PERMANENT DATA FILE?Y=YES;N=NO"
20470 READ,AAA
20480 IF(AAA.EQ.1HY)GO TO 10540
20490 PRINT,"WE WILL HELP YOU SET UP YOUR DATA FILE"
20500 PRINT,"YOU MUST SUPPLY 29 DATA ITEMS AND A FILE NAME"
20510 PRINT,"ENTER YOUR NEW 5-LETTER FILE NAME"
20520 READ,AAB
20530 CALL DATAF($22275)
20540 GO TO 10610
20550 10540 PRINT,"ENTER YOUR 5-LETTER FILE NAME"
20560 NSTART=1
20570 10560 READ,AAB
20575 IF(AAB.EQ.5HSTOP) RETURN 1
20580 GO TO 10610
20590 10580 PRINT 10590,AAB
20600 10590 FORMAT("NO FILE ",A8,." ENTER FILE NAME OR STOP")
20610 GO TO 10560
20620*10610 ENCODE(AAC,10420) "/",AAB,";"
20630 ENTPY MAIN(*)
20640 10630 CONTINUE
20650 CALL ATTACH(1,AAC,3,0,ISTAT,)
20660 CALL TEST(ISTAT,IDECK)
20670 GO TO(10670,10580,941,941,10580),IDECK
20680 10670 CONTINUE;KK=1
20690 READ(1,10100) TYPE,XN,RUN
20700 READ(1,10090) Z1,ZL,ZR,XL1,XL2,XL3,XL4,XL5,
20710&KK1,XK2,XK3,XK4,DTS,M,N,IVALV,IPPIN1,IPPIN2,IDE1,IDE2
20720 IF(ABS(TYPE).LT.0.99.0P.ABS(TYPE).GT.1.01)GO TO 294
20730 IF(IVALV.EQ.2)GO TO 10750

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H5320S CONT.

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20740 READ(1,10110,END=10770)(XBB(I),I=1,N)
20750 GO TO 10770
20760 10750 READ(1,10110,END=10760)SAG,TV1,T1,TLAG,TV2
20770 10760 CALL VAL2(SAG,TV1,T1,TLAG,TV2,DTS,N,EE1,XBB)
20780 10770 IF(NSTART.EQ.0)GO TO 10820
20790 PPINT,"DO YOU WISH TO CHANGE ANY DATA BEFORE YOU START? YES OR NO?"
20800&""
20810 READ,AAA;IF(AAA.EQ.1HY) KK=1
20820 IF(AAA.EQ.1HY) CALL PRIN1(S10630)
20830 10820 CONTINUE
20840 NSTART=0
20850 DTM=DTS/60.0; T3=(N-1)*DTM; NC=XN; AR=(XN*XL2*XL3)/(XL4*XL5)
20860 DO 10930 I=2,M+1
20870 IF(I.GT.N)XBB(I)=XBB(I-1)
20880 XTC(I)=XT(I-1)+DTM
20890 IF(XBB(I).LE.0.2) XKV(I)=(10.0**((B-.2*C))+(.04/XBB(I)**2))
20900 IF(XBB(I).GE.0.2) XKV(I)=10.0**((B-C*XBB(I)))
20910 IF(XBB(I).LE.0.3) XCC(I)=D+(E-D)*COS(3.141593*(XBB(I)/0.60))
20920 IF(XBB(I).GE.0.3) XCC(I)=F-(F-D)*COS(((XBB(I)-.3)*3.141593)/1.4)
20930 XK(I)=XK1+XK2+XK3+XK4+XKV(I)
20940 10930 CONTINUE
20950 XKT=XK1+XK2+XK3+XK4+10.0**((B-C))
20960 XKC=SQRT(1/XKT);PRINT 10950,PRIN;10950 FORMAT(/A35//)
20970 IF(IPRIN1.EQ.1)PRINT 10120,XL1,XL2,XL3,NC,XL4,XL5,
20980&XK1,XK2,XK3,XK4,XKT,XKC,ZU,ZL,ZR
20990 BB2=XL3*EE1
21000 IF(IVALV.EQ.2)PPINT 10210,TV1,T1
21010 IF(IVALV.EQ.2.AND.T1.LT.TV1)PRINT 10230,TLAG,EE2,TV2,T3,N
21020 IF(IVALV.EQ.1)PPINT 10260,T3
21030C SET INITIAL CONDITIONS
21040 IF(TYPE)11040,11060,11060
21050 11040 Z(I)=ZU;ZPEF=ZL;ZDW(I)=ZU
21060 GO TO 11070
21070 11060 Z(I)=ZL;ZPEF=ZU;ZDW(I)=ZL
21080 11070 CONTINUE
21090 XCC(I)=E;M1=M;M2=M;ZUW(I)=ZU;ZOT=0.0;ZV(I)=ZL
21100 M3=M
21110 H(I)=ZU-ZL;HLV(I)=H(I);HLT(I)=H(I)
21120C START NUMERICAL INTEGRATION
21130 DO 11270 I=1,M-1
21140 V(I+1)=PPED(Z(I),V(I),XK(I+1),TYPE,ZPEF,AP,DTS,XL1)
21150 Z(I+1)=ZNEW(Z(I),V(I),V(I+1),AP,DTS,TYPE)
21160 IF(ABS(XL1*(V(I+1)-V(I))).GE..5*XK(I+1)*DTS*V(I+1)**2)M3=I-1
21170 IF(I.GT.M3.OR.I.GT.M1)GO TO 11250
21180 DO 11230 J=1,10
21190 V(I+2)=PPED(Z(I+1),V(I+1),XK(I+2),TYPE,ZPEF,AP,DTS,XL1)
21200 V(I+1)=COPR(Z(I),V(I),XK(I+1),V(I+2),TYPE,ZPEF,AP,DTS,XL1)
21210 ZCHEC=ZNEW(Z(I),V(I),V(I+1),AP,DTS,TYPE)
21220 IF(ABS(ZCHEC-Z(I+1)).LE.0.0001)GO TO 11240
21230 Z(I+1)=ZCHEC

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H5320S CONT.

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21240 11230 CONTINUE
21250 11240 Z(I+1)=ZCHEC
21260 11250 IF(M2.EQ.0.AND.V(I+1).LT.0.0)M2=1
21270 IF(M1.EQ.0.AND.TYPE*(ZREF-Z(I+1)).LE.0.0) M1=1
21280 11270 CONTINUE
21290 ERROR=0.0
21300 PRINT 10410
21310 DO 11350 I=2,M2
21320 YY=CORR(Z(I-1),V(I-1),XK(I),V(I+1),TYPE,ZREF,AR,DTS,XL1)
21330 ERROR=(YY-V(I))**2+ERROR
21340 IF(I.EQ.M1)PRINT 10400,I,ERROR
21350 IF(I.EQ.M2)PRINT 10400,I,ERROR
21360 11350 CONTINUE
21370C END OF DIFF. EQNS.
21380 DO 11690 I=2,M
21390 VH(I)=(V(I)**2)/64.4
21400 Q(I)=V(I)*XL2*XL3*XN
21410 R(I)=(Q(I)*60.0)/(XL4*XL5)
21420 HI(I)=XL1*(V(I+1)-V(I-1))/(64.4*DTS)
21430 HL1(I)=XK1*VH(I)
21440 HL2(I)=XK2*VH(I)
21450 HLV(I)=XKV(I)*VH(I)
21460 HL3(I)=XK3*VH(I)
21470 HL4(I)=XK4*VH(I)
21480 HLT(I)=XK(I)*VH(I)
21490 H(I)=TYPE*(ZREF-Z(I))
21500 IF(V(I).GE.0.0)VHVC(I)=VH(I)/(XCC(I)*XBB(I))**2
21510 IF(V(I).LT.0.0)VHVC(I)=VH(I)
21520 IF(TYPE)11590,11590,11520
21530 11520 IF(V(I).GT.0.0)ZUW(I)=ZU-(1.0+XK1+XK2)*VH(I)
21540 IF(V(I).LE.0.0)ZUW(I)=ZU-(1.0-XK1-XK2)*VH(I)
21550 IF(V(I).GE.0.0)ZDW(I)=Z(I)+XK4*VH(I)
21560 IF(V(I).LT.0.0)ZDW(I)=Z(I)-XK4*VH(I)
21570 IF(V(I).GT.0.0)ZV(I)=ZUW(I)+VH(I)-VHVC(I)
21580 IF(V(I).LE.0.0)ZV(I)=ZUW(I)-VHVC(I)
21590 GO TO 11640
21600 11590 ZUW(I)=ZU
21610 IF(V(I).GE.0.0)ZDW(I)=Z(I)-(1.0+XK1+XK2)*VH(I)
21620 IF(V(I).LT.0.0)ZDW(I)=Z(I)-(1.0-XK1-XK2)*VH(I)
21630 IF(V(I).GE.0.0)ZV(I)=ZDW(I)+VH(I)-VHVC(I)
21640 IF(V(I).LT.0.0)ZV(I)=ZDW(I)-VHVC(I)
21650 11640 CONTINUE
21660 IF(V(I).LE.0.0)CI(I)=9.99
21670 IF(V(I).GT.0.0)CI(I)=(ZV(I)-ZP+XL3*(1.-XCC(I)*XBB(I)))/VHVC(I)
21680 &+33.0/VHVC(I)
21690 IF(CI(I).GE.10.0)CI(I)=9.99
21700 11690 CONTINUE
21710 XTX=XT(M1)+DTM*(ZREF-Z(M1))/(Z(M1+1)-Z(M1))
21720 XTM=XT(M2)
21730 ZOT=Z(M2)-ZREF

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H5320S CONT.

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21740 IF(M1.EQ.M)PRINT,"LOCK OPERATION IS NOT COMPLETE"
21750 IF(M2.EQ.M)PRINT,"LOCK DOES NOT COMPLETE OVERTRAVEL"
21760 IF(M1.LT.M.AND.TYPE.GT.0.0)PRINT 10390,XTX
21770 IF(M1.LT.M.AND.TYPE.LT.0.0)PRINT 10380,XTX
21780 IF(M2.LT.M)PRINT 10270,XTM,ZOT
21790 PRINT 10290
21800 PRINT 10330,(XT(I),XBB(I),XCC(I),XKV(I),Q(I),Z(I),ZUW(I),
21810&ZV(I),ZDW(I),CI(I),I=1,N,IDEL1)
21820 PRINT 10330,(XT(I),XBB(I),XCC(I),XKV(I),Q(I),Z(I),ZUW(I),
21830&ZV(I),ZDW(I),CI(I),I=N+1DEL2,M,IDEL2)
21840 IF (IPRIN2)11900,11900,11840
21850 11840 CONTINUE
21860 PRINT 10340
21870 PRINT 10370,(XT(I),RR(I),V(I),VH(I),VHVC(I),HLV(I),HLT(I),
21880&HI(I),H(I),I=1,N,IDEL1)
21890 PPINT 10370,(XT(I),RR(I),V(I),VH(I),VHVC(I),HLV(I),HLT(I),
21900&HI(I),H(I),I=N+1DEL2,M,IDEL2)
21910 11900 CONTINUE
21920 PPINT,"DO YOU NEED TO STORE THE OUTPUT IN A DATA FILE?Y OR N"
21930 READ,AAA
21940 IF(AAA.EQ.1HN)GO TO 320
21950 PRINT,"ENTER A 5-LETTER FILE NAME"
21960 READ,AAD
21970 LINE(1)=100
21980 DO 11980 I=2,M
21990 11980 LINE(I)=LINE(I-1)+2
22000 ENCODE(AAE,10420,"/",AAD,";")
22010 ENCODE(CFILE,59) "CF,/",AAD,"B/1,35/,R,W#"
22020 CALL ATTACH(2,AAE,3,0,ISTAT,)
22030 CALL TEST(ISTAT,IDEC)
22040 GO TO(172,173,175,175),IDEC
22050 173 CALL ACCESS(CFILE,$175)
22060 172 CONTINUE
22070 CALL ATTACH(2,AAE,3,,)
22080 CALL HEADER(M)
22090 DO 12075 I=1,M;12075 XKV(I)= ALOG10(XKV(I))
22100 WPITE(2,10430) (LINE(I),XT(I),XBB(I),XCC(I),XKV(I),Q(I),Z(I),
22110&ZV(I),ZDW(I),CI(I),RP(I),V(I),VH(I),VHVC(I),HLV(I),
22120&HLT(I),HI(I),H(I),I=1,M)
22130 61 CALL DETACH(2,,)
22140 PRINT 160,AAD
22150 160 FORMAT("YOUR OUTPUT VALUES ARE STORED IN FILE ",A8)
22160 59 FORMAT(A4,A8,A13)
22170 GO TO 320
22180 175 PRINT,"FILE PROBLEM; ILLEGAL CHAP; BUSY; OR SYSTEM PROBLEM"
22190 PPINT,"OUTPUT VALUES NOT SAVED AS REQUESTED"
22200 320 CONTINUE
22210 GO TO 293
22220 294 PRINT,"PROGRAMMED STOP; TYPE NOT EQUAL 1 OR -1"; RETURN 1
22230 941 PRINT 946,ISTAT

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H5320S CONT.

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22240 946 FORMAT("FILE PROBLEM. CALL FTS 542-2403 AND GIVE THIS NUMB
22250&ER ",012)
22260 293 CONTINUE
22270 CALL DETACH(1,,); RETURN
22275 22275 RETURN 1
22280 END
22290 FUNCTION PRED (ZST,VST,XKF,TYPE,ZREF,AR,DTS,XL1)
22300 XC=(64.4/XKF)*(TYPE*(ZREF-ZST)-VST*(.5*AR*DTS-XL1/(32.2*DTS)))
22310 XB=(64.4/XKF)*(.5*AR*DTS+XL1/(32.2*DTS))
22320 IF(XC.GE.0.0)PRED=-.5*XB+.5*SQRT(XB**2+4.*XC)
22330 IF(XC.LT.0.0)PRED=.5*XB-.5*SQRT(XB**2-4.*XC)
22340 RETURN;END
22350 FUNCTION CORR (ZST,VST,XKF,VAH,TYPE,ZREF,AR,DTS,XL1)
22360 XC=(64.4/XKF)*(TYPE*(ZREF-ZST)-.5*VST*AR*DTS-XL1*(VAH-VST)/
22370&(64.4*DTS))
22380 XB=32.2*AR*DTS/XKF
22390 IF(XC.GE.0.0)COPP=-.5*XB+.5*SQRT(XB**2+4.*XC)
22400 IF(XC.LT.0.0)COPR=.5*XB-.5*SQRT(XB**2-4.*XC)
22410 RETURN;END
22420 FUNCTION ZNEW (ZST,VST,UF,AR,DTS,TYPE)
22430 ZNEW=ZST+TYPE*.5*AR*DTS*(VST+UF)
22440 RETURN;END
22450 SUBROUTINE TEST(ISTAT,IDECK)
22460 DIMENSION ITEST(5)
22470 DATA ITEST/000,005,037,004,034/
22480 IDECK=3
22490 ISTAT=FLD(6,6,ISTAT)
22500 IF(ISTAT.EQ.1)TEST(3).OR.1STAT.EQ.1)TEST(1)) IDECK=1
22510 IF(1STAT.EQ.1)TEST(2)) IDECK=2
22520 IF(1STAT.EQ.1)TEST(4)) IDECK=4
22530 IF(1STAT.EQ.1)TEST(5)) IDECK=5
22540 RETURN;END
22550 SUBROUTINE VAL2(A,TV1,T1,TLAG,TV2,DTS,N,BB1,XBB)
22560 DIMENSION XT(201),XBB(201)
22570 T2S=0.0;BB1=0.0;DTM=DTS/60.0;XT(1)=0.0;PI=3.141593
22580 IF(TV1-DTM)182,186,186
22590 182 PRINT,"YOUR 1ST VALVE RATE IS LESS THAN ONE TIME STEP"
22600 PRINT,"ENTER VALVE OPENING RATIO AT END OF 1ST TIME STEP"
22610 ?FAD,BB1
22620 T1=0.0
22630 186 CONTINUE
22640 IF(TV1.GE.DTM)BB1=T1/TV1-A*SIN(PI*T1/TV1)
22650 T2S=BB1*TV2
22660 DO 214 J=1,6
22670 T2N=T2S+(TV2*EE1-T2S+A*TV2*SIN(PI*T2S/TV2))/
22680&(1.0-A*PI*COS(PI*T2S/TV2))
22690 IF(ABS(T2N/T2S-1.0).LE.0.0001) GO TO 215
22700 214 T2S=T2N
22710 215 CONTINUE
22720 T2=T1+TLAG

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H5320S CONT.

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22730 T3=T2-T2*E+T1*2
22740 N=T3/DTM+2
22750 DO 52 I=2,N
22760 XT(I)=XT(I-1)+DTM
22770 IF(XT(I).LE.T1)YBB(I)=YT(I)/T1-A*SIN(PI*YT(I)/T1)
22780 IF(XT(I).GT.T1.AND.XT(I).LE.T2)YBB(I)=BB1
22790 IF(XT(I).GT.T2)YBB(I)=(YT(I)-T2+T2S)/T2-A*SIN(PI*(YT(I)-T2+T2S)
22800&/T1*2)
22810 52 CONTINUE
22820 IF(YBB(N).GT.1.0)YBB(N)=1.0
22830 PEXIT;END
22840 SUBROUTINE DATAF(*)
22850 COMMON LQZ,LQX,YBB(201),TYPE,PIN,YN,ZU,ZL,ZP,YL1,YL2,YL3,YL4,XLS,
22860&YK1,YK2,YK3,YK4,DTM,M,IVALV,N,EBI,AAE,T1,T2,TLAG,T1/2,AAC,SAG,IPR
22870&IN1,IPFIN2,IDE1,IDE2,NSTART,KK,IVAL1,IVAL2,LINE(201)
22880 CHARACTER PIN*35,AAB*8,AAC*10,CFILE*24
22890 IF(LQX.EQ.3) GO TO 11520
22900 ENTRY PIN(*)
22910 IF(LQZ.EQ.2) GO TO 11520
22920 CALL PRINT
22930 IF(NSTART.EQ.0) GO TO 11520
22940 LQZ=2;PEWIND 1
22950 11520 KKK=29
22960 GO TO 111,112),LQZ
22970 112 CALL PEPI(N(KKK,LQX,JKL)
22980 GO TO(1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,
22990&24,25,26,27,28,29,30),JKL
23000 111 CONTINUE
23010 GO TO(1,112),LQZ
23020 1 PRINT,"AA-ENTER I=FILL;0P -I=EMPTY;OP 0=TERMINATE NOW"
23030 READ,TYPE
23040 IF(AFF(TYPE).LT.0.99)GO TO 174
23050 GO TO(2,112),LQZ
23060 2 PRINT,"AD-ENTER YOUP PROBLEM NAME"
23070 READ 33,PIN
23080 33 FORMAT(A35)
23090 GO TO(3,112),LQZ
23100 3 PRINT,"AC-ENTER I=1-CIVL;0P 2=2-CIVL. OPERATION"
23110 READ,YN
23120 GO TO(4,112),LQZ
23130 4 PRINT,"AD-ENTER UPPEF POOL ELEVATION"
23140 READ,ZU
23150 GO TO(5,112),LQZ
23160 5 PRINT,"AE-ENTER LOWER POOL ELEVATION"
23170 READ,ZL
23180 GO TO(6,112),LQZ
23190 6 PRINT,"AF-ENTER CIVL". POOF ELEVATION"
23200 READ,ZP
23210 GO TO(7,112),LQZ
23220 7 PRINT,"AG-ENTER CIVL". LENGTH"

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23230 READ,XL1
23240 GO TO(3,112),L02
23250 3 PPINT,"AH-ENTER C"LV. WIDTH"
23260 READ,XL2
23270 GO TO(9,112),L02
23280 9 PPINT,"AI-ENTER C"LV. HEIGHT"
23290 READ,VL3
23300 GO TO(10,112),L02
23310 10 PPINT,"AJ-ENTER CHAMBER LENGTH"
23320 READ,XL4
23330 GO TO(11,112),L02
23340 11 PPINT,"AK-ENTER CHAMBER WIDTH"
23350 READ,XL5
23360 GO TO(12,112),L02
23370 12 PPINT,"AL-ENTER C"LV. INTAKE LOSS COEF."
23380 READ,YK1
23390 GO TO(13,112),L02
23400 13 PPINT,"AM-ENTER U-S C"LV. LOSS COEF."
23410 READ,YK2
23420 GO TO(14,112),L02
23430 14 PPINT,"AN-ENTER D-S C"LV. LOSS COEF."
23440 READ,YK3
23450 GO TO(15,112),L02
23460 15 PPINT,"AO-ENTER C"LV. EXIT LOSS COEF."
23470 READ,YY4
23480 GO TO(16,112),L02
23490 16 PPINT,"AR-ENTER TIME STEP IN SECONDS"
23500 READ,DT5
23510 GO TO(17,112),L02
23520 17 PPINT,"AR-ENTER TOTAL NO. OF CALC. STEPS DESIRED"
23530 READ,M
23540 GO TO(18,112),L02
23550 18 PPINT,"AP-ENTER TYPE OF VALVING(1 OR 2; SEE TABLE)"
23560 READ,I"VAL"
23570 IF(I"VAL".EQ.2) GO TO 50
23580 GO TO(19,11556),L02
23590 11556 L02=1
23600 19 PPINT,"AS-ENTER NO. OF PATIOS TO BE ENTERED"
23610 READ,N
23620 GO TO(20,112),L02
23630 20 PPINT,"AT-ENTER VALVE PATIOS(SEP. BY COMMAS)"
23640 READ,(YBB(I),I=1,N)
23650 IF(I"VAL".EQ.0.AND.I"VAL2.EQ.1) L02=2
23660 I"AL1=1
23670 IF(KK.EQ.1) L02=2
23680 GO TO 60
23690 50 GO TO(21,11591),L02
23700 11591 L02=1
23710 21 PPINT,"A"-ENTER "VALVE SAG"
23720 READ,SAG

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H5320s CONT.

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23730 GO TO(22,112),L02
23740 22 PRINT,"AV-ENTER FIRST VALVE RATE"
23750 READ,TV1
23760 GO TO(23,112),L02
23770 23 PRINT,"AW-ENTER TIME VALVE STOPS MOTION(MINUTES)"
23780 READ,T1
23790 GO TO(24,112),L02
23800 24 PRINT,"AY-ENTER DURATION OF STOP(MINUTES)"
23810 READ,TLAG
23820 GO TO(25,112),L02
23830 25 PRINT,"AY-ENTER FINAL VALVE RATE"
23840 READ,TV2
23850 IF(IVAL1.EQ.1.AND.IVAL2.EQ.0) L02=2
23860 IVAL2=1
23870 IF(KK.EQ.1) L02=2
23880 60 CONTINUE
23890 GO TO(26,112),L02
23900 26 PRINT,"AZ-ENTER 1ST OUTPUT CONTROL; I=DO, 0=DO NOT PRINT"
23910 READ,IPPIN1
23920 GO TO(27,112),L02
23930 27 PRINT,"BA-ENTER 2ND OUTPUT CONTROL; I=DO, 0=DO NOT PRINT"
23940 READ,IPPIN2
23950 GO TO(28,112),L02
23960 28 PRINT,"BB-ENTER FIRST OUTPUT RATE; I=EVERY VALUE"
23970 READ,IDE1
23980 GO TO(29,112),L02
23990 29 PRINT,"BC-ENTER FINAL OUTPUT RATE; 2=EV. 2ND VALUE"
24000 READ,IDE1
24010 GO TO(30,112),L02
24020 30 CONTINUE
24030 LINE(1)=100
24040 DO 54 J=2,N/10+6
24050 54 LINE(J)=LINE(J-1)+2
24060 ENCODE(AAC,55)"/",AAB,";"
24070 DO 62 J=N+1,N+10
24080 62 XBB(J)=YBB(J-1)
24090 ENCODE(CFILE,59)"CF,/",AAB,"B/1,3/,P,W"
24100 CALL ATTACH(1,AAC,3,0,ISTAT,)
24110 CALL TEST(ISTAT,1DEC)
24120 GO TO(172,173,175,175,175),IDE1
24130 173 CALL ACCESS(CFILE,$175)
24140 172 CONTINUE
24150 CALL ATTACH(1,AAC,3,,)
24160 WRITE(1,56)LINE(1),TYPE,YN,PIN,LINE(2),ZL,ZP,LINE(3),
24170 &XL1,XL2,XL3,XL4,XL5,LINE(4),XX1,XX2,XX3,XX4,LINE(5),DTS,
24180 &M,N,IVAL1,IPPIN1,IPPIN2,IDE1,IDE2
24190 DO 58 J=1,N/10+1
24200 IF(I"AL".EQ.2) WRITE(1,57)LINE(6),SAG,TV1,T1,TLAG,TV2
24210 IF(I"AL".EQ.2) GO TO 61
24220 58 WRITE(1,57)LINE(J+5),(XBB(I),I=10*J-9,10*J)

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H53205 CONT.

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24230 61 CALL DETACH(1,,)
24240 55 FORMAT(A1,A8,A1)
24250 59 FORMAT(A4,A8,A12)
24260 56 FORMAT(13,2F4.0,A35,,13,3F8.3,,13,5F8.3,,13,4F8.3,,)
24270&13,F5.1,214,512)
24280 57 FORMAT(13,10F6.3)
24290 GO TO 200
24300 174 PRINT,"PROGRAMMED STOP; TYPE=0; REVIEW YOUR DATA"; RETURN 1
24310 175 PRINTFILE PROBLEMS; ILLEGAL CHARACTER; BUSY; OF SYSTEM PROB."
24320 200 IF(NSTART.EQ.1) GO TO 1192
24330 RETURN
24340 1192 NSTART=0; L02=1; RETURN 1; END
24350 S'BPOINTINE PRINTT
24360 CHARACTER AAA*1
24370 PPINT,"SHOULD I PRINT A TABLE OF INPUT CODES? Y=YES/N=NO"
24380 READ,AAA
24390 IF(AAA.EQ.1HN)GO TO 4
24400 PPINT 2
24410 2 FORMAT("CODE VARIABLE",17X,"DESCRIPTION"/
24420&"AA TYPE",3X,"1=FILL; -1=EMPTY; 0=TERMINATE PNT"/
24430&"AB PNT",4X,"PROBLEM NAME(35 SPACES AVAILAELE)"/
24440&"AC XN",5X,"1=ONE CILV.; 2=TWO CILV/EPT OPERATION"/
24450&"AD Z1",5X,"UPPER POOL ELEV.(FT-DATIM)"/
24460&"AE ZL",5X,"LOWER POOL ELEV.(FT-DATIM)"/
24470&"AF ZP",5X,"CILV. POOF ELEV.(FT-DATIM) AT VALVE"/
24480&"AG XL1",4X,"CILV. LENGTH(FT)"/
24490&"AH XL2",4X,"CILV. WIDTH(FT)"/
24500&"AI XL3",4X,"CILV. HEIGHT(FT)"/
24510&"AJ XL4",4X,"CHAMBER LENGTH(FT)"/
24520&)
24530 PPINT 3
24540 3 FORMAT(
24550&"AK XL5",4X,"CHAMBER WIDTH(FT)"/
24560&"AL XK1",4X,"INTAKE LOSS COEF."/-
24570&"AM XK2",4X,"S-S CONDUIT LOSS COEF."/-
24580&"AN XK3",4X,"E-S CONDUIT LOSS COEF."/-
24590&"AO XK4",4X,"EXIT LOSS COEF."/-
24600&/"NOTE: LOSS COEF.=SQUARE ROOT OF 1/(XK1+XK2+XK3+XK4+0.1)"/-
24610&"AP DTS",4X,"TIME STEP(SEC.) FOR CALCULATIONS"/
24620&"AQ M",6X,"NO. OF STEPPED VALUES(INCL. TIME=0.0)"/
24630&"AP IVALV",2X,"VALVE OPTIONS: 1=POINT-BY-POINT"/
24640&,25X,"2=USE PROGRAMMED FUNCTIONS"/
24650&/"IF IVALV=1"/-
24660&"AS N",6X,"NO. OF VALUES OF VALVE OPENING RATIOS TO BE READ"/
24670&,11X,"(INCL. 0.0 AT TIME=0.0 AND 1.0 AT VALVE FULL OPEN)"/
24680&,11X,"THESE VALUES ARE DTS SEC. APART(SEE AP, ABOVE)"/
24690&"AT XBC(I)",1X,"N VALUES(SEPARATE WITH COMMAS) OF"
24700&,11X,"VALVE OPENING RATIOS"/
24710&/"IF IVALV=2"/-
24720&"AU SAG",4X,"NORMAL SAG AT 1/2 VALVE TIME(APPROX.=0.1)"/

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H53205 CONT.

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24730&)
24740 PRINT 6
24750 6 FORMAT(
24760&"A" TV1", 4X, "INITIAL OPENING RATE(MINS. TO FULLY OPEN)"/
24770&"AW TI", 5X, "VALVE MOTION STOPS AT TI MINS."/"
24780&"AY TLAG", 3X, "VALVE HOLDS POSITION FOR TLAG MINS."/"
24790&"AY TV2", 4X, "FINAL OPENING RATE(MINS. TO FULLY OPEN)"/
24800&/"NOTE: NON-STEPPED OPENING; TI=TV1, TLAG=0.0, TV2=TV1"/
24810&/"NOTE: THE NEXT ITEMS CONCERN THE PRINTED OUTPUT"/
24820&"A? IPPIN1", 1X, "1=PRINTS OUT ITEMS AA THRU A0, ABOVE"/
24830&, 1IX, "0=DO NOT PRINT ITEMS AA THRU A0"/
24840&"BA IPPIN2", IX, "LOSS DISTRIBUTIONS: 1=PRINT, 0=DO NOT PRINT"/
24850&"BE IDEL1 PRINT 1ST AND EV. IDEL1*DTS SEC TO VALVE FULL OPEN"/
24860&"EC IDEL2", 2X, "PRINT EV. IDEL2*DTS SEC. TO (M-1)*DTS SEC."/"/
24870 4 CONTINUE
24880 PETI"PN; END
24890 SUBROUTINE HEADER(M)
24900 14840 FORMAT("08 H5320 18 15 EDGE"/"09 (15(/), (3X, 3F6.2, F9.2, F7.0,
24910&"77.2, 4F6.2, 5F7.2))"/"10", 18(1X,13)/"11", 18(" 1"))
24920 14860 FORMAT("12 C"IVE DESIGNATIONS FOR H5320 APE:"//13 1=TIME", 2
24930&4X, "10=CAVITATION PARAMETER"/"14 2=VALVE OPENING RATIO", 9X, "11=PA
24940&TE-OF-PISE"/"15 3=CONTRACTION COEF.", 1IX, "12=VELOCITY AT REF AREA
24950&"/"16 4=LOG(VALVE LOSS COEF.)", 7X, "13=VELOCITY HD AT REF AREA"/"1
24960&7 5=TOTAL INFLOW", 16X, "14=VELOCITY HD AT VENA CONT"/"18 6=LOCK W
24970&ATEP SURFACE(W-S)", 5X, "15=HEADLOSS THRU VALVE"/"19 7=D/S VALVE VE
24980&LL V-S", 10X, "16=TOTAL HEADLOSS"/"20 8=PIEZ HD BELOW VALVE", 9X, "17
24990&=INERTIAL TERM"/"21 9=D/S VALVE WELL V-S", 10X, "13=W-S DIFFERENTIA
25000&L"/"22 UNITS FOR ABOVE VARIABLES ARE:"//23 MINUTES=1", 8X, "FT/MIN
25010&=11"/"24 NONE=2, 3, 4, 10", 4X, "FT/SEC=12"/"25 CFS=5", 12X, "FT=13, 14,
25020&15, 16, 17, 18"/"26 FT-DATUM=6, 7, 8, 9")
25030 WRITE(2,14840) (M, I=1, 18)
25040 WRITE(2,14360)
25050 PETI"PN
25060 END
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